4 SITE 380

The Shipboard Scientific Staff[1]

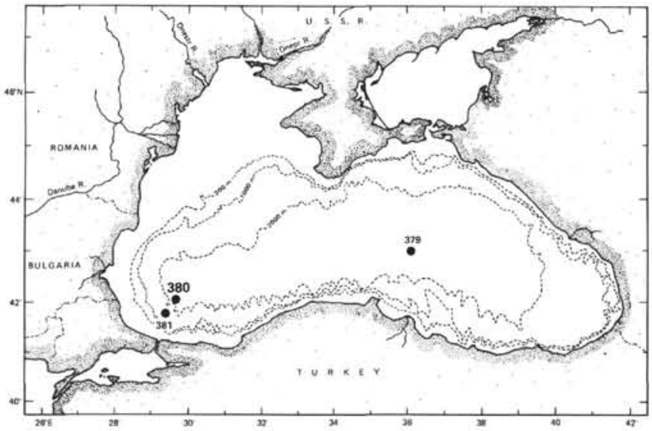

Figure 1. *Bathymetric chart showing the position of Site 380 and other Leg 42B sites in the Black Sea. Contour interval in meters.*

SITE DATA

Dates: 30 May-7 June 1975

Time: 175 hours

Position (Figure 1): 42°05.94′, 29°36.82′E

Holes Drilled: 2

Water Depth by Echo-Sounder: 2107 corr. meters

Maximum Penetration: 1073.5 meters

Total Core Recovered: 591.1 meters from 119 cores

Age of Oldest Sediment: Late Miocene?

Principal Results:

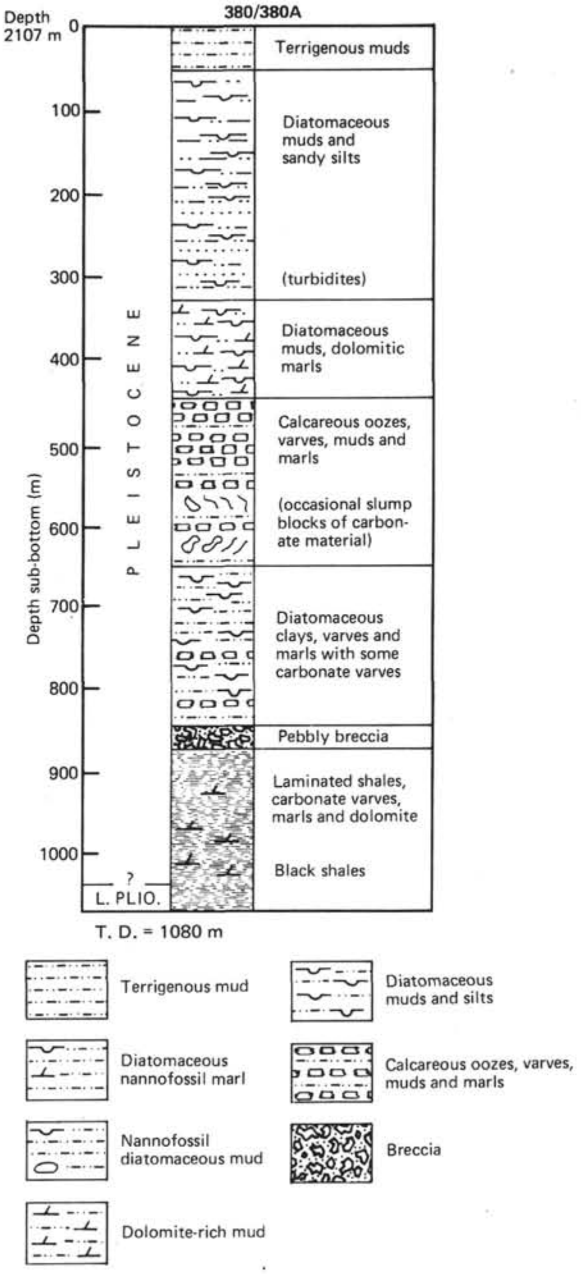

Figure 2. *Lithostratigraphic section recovered at Site 380.*

Site 380 was drilled near the Bosporus on the basin apron of the Black Sea in a water depth of 2107 corrected meters. The position was 42°05.94′N and 29°36.82′E and maximum penetration was 1073.5 meters. Two holes were drilled and 591.1 meters of sediment were collected from 119 cores. The first hole (380) was abandoned due to an injury, the second (380A) was situated near the first. Coring was essentially continuous except for the upper 332.5 meters of 380A as we sought to reach the abandoned depth of Site 380, thus a continuously cored section to 1073.5 meters was obtained. Several more tests were made of the pressure core barrel and a total of eight heat flow measurements were made. Hole 380A had to be abandoned because of an increase in hole pressure suggesting collapse of soft shales.

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The sediment section, as at Sites 379 and 381, was not very rich in fauna and flora (with the general exception of spores and pollen), thus age determination was difficult. The sedimentary sequence can be divided into five main units and several subunits, however, in general the upper part of the section is of terrigenous origin whereas chemical sediments are more typical of the lower 600 or 700 meters. Sedimentation rates in the range of 30-40 cm/1000 yr. appear likely for the Quaternary section (assuming a 1.5 to 2 m. y. age for the beginning of the Pleistocene glaciation).

Sediments having high amounts of carbonate intercalations, called Seekreide (lake chalk) because of their similarity to sediments found in some modern Swiss lakes, were common in the lower and middle parts of the section. It appears that late Miocene was the oldest age reached by drilling at this site.

The most important microfossil group appears to be the pollen and spores. As with Site 379 three major steppe peaks and four cooler dryer periods were observed. These can be used for correlation between sites, although some controversy exists concerning this correlation (see Summary chapter, this volume).

The cores were generally very gassy, but methane/ethane ratios stayed within a safe range. Interstitial salinities slowly increased with depth reaching a maximum of 98‰. Physical properties of sediments were difficult to measure because of the high gas content, but where measured tended to be variable, mainly because of changes in sediment type. Sound velocity increased in the lower 200 meters of the hole going from about 1.75 to 2.1 km/sec up to about 2.9 to 5.9 km/sec. Five of the eight heat flow values are considered to be representative of in situ conditions and show a geothermal gradient of 35°C/km similar to the 36°C/km measured at Site 379. Heat flow is $0.99 \pm 0.10 \times 10^{-6}$ cal/cm^2 sec—again very similar at Site 379. Some of the sub-surface seismic reflectors appear correlative with cored sedimentary units.

BACKGROUND AND OBJECTIVES

The Black Sea, which is one of the largest semi-enclosed marine basins, has long been of interest to oceanographers because of its unusual history and environment. It is believed to be a remnant of the old Tethys Sea which existed prior to the major separation of the continents about 200 million years ago. Since that time it may have been a site of continuous deposition.

At present the Black Sea has only one opening to the ocean, through the Bosporus, which in turn connects to the Mediterranean. In earlier times connections with the Caspian and other basins may have existed. The sill depth of the Bosporus is about 50 meters. If sea level were to drop by this amount or more, as it did within the Wisconsin glaciation, the Black Sea would be disconnected from the Mediterranean and its source of salt water. In the most recent glacial drop of sea level, the Black Sea almost became a fresh water lake.

Pleistocene sea level change and past connection with other basins will have a decisive influence on the water chemistry, biological population, and sediments of the Black Sea. Since these sea level changes are climatically controlled the geochemical and paleontological data from the Black Sea sediments can be used to establish the paleoclimatological and paleoecological record of this area as well as elucidating past worldwide sea level changes.

This site, as with Site 379, had as one of its main objectives the obtaining of a complete Pleistocene section. With the apparent failure to completely satisfy this objective at Site 379, because of the high sedimentation rate there, the importance of getting a complete long section at this site is increased.

The main objectives of this site were:

1) to obtain as complete as possible a Pleistocene and Pliocene stratigraphic and biostratigraphic section.

2) to detail the paleooceanographic history of the Black Sea, especially in relationship to eustatic sea level changes and variations of inflow from the Mediterranean through the Bosporus.

3) to obtain further information on the nature and history of the Black Sea depression.

4) to determine the age, composition, and significance of several strong acoustic reflectors.

OPERATIONS

Glomar Challenger approached the site area on a course of 262°T. A Woods Hole Oceanographic Institution seismic profile (A-II 49, profile 21; see Ross et al., 1974, fig. 14) was the basis for the original choice of this site; however, a brief survey was necessary to pick the exact location. The sedimentary section was thinner here than in the more central positions of the basin (compare Figure 18 in Site 379, chapter with Figures 3 and 33). Site 380 was near the base of the basin slope on the basin apron. An initial pass at 262° T over the area showed a favorable locality for drilling, but some other areas were explored to the southwest and west of this initial area. Upon the return to the initial pass, a 13.5-kHz beacon was dropped at 2300 LCT (29 May 1975) while running on a course of 031° T. The ship made a Williamson turn, retrieved the seismic equipment and returned to the site. By 0000 LCT we were maneuvering over the beacon and pipe was lowered at 0130 LCT on 30 May. Water depth from the drill floor was 2117 corrected meters and bottom was felt by the drill pipe at 2115 meters.

Two holes were drilled at Site 380; the first to 370.5 meters, the second (380A) to 1073.5 meters. Hole 380 was terminated because of an injury to one of the roughnecks. Pipe was pulled in an attempt to get him medical attention in Istanbul. However, before reaching Istanbul two Turkish naval boats arrived and transferred him to a hospital. A new Hole 380A was occupied about 100 feet to the south and 100 feet to the east of Hole 380.

On Hole 380, four heat flow measurements and two tests of the pressure core barrel were made. Coring was continuous, following the recommendation of the Safety Panel. A total of 40 cores was cut and 169.5 meters of core were recovered (45.7%) (Table 1).

Following the accident we started pulling out of the hole at 0500 LCT on 1 June and by 1246 LCT all pipe was on board. We started towards Istanbul but we were able to transfer the injured roughneck before moving too far. By 1420 LCT we had returned to the beacon and started lowering pipe on Hole 380A. Hole 380A

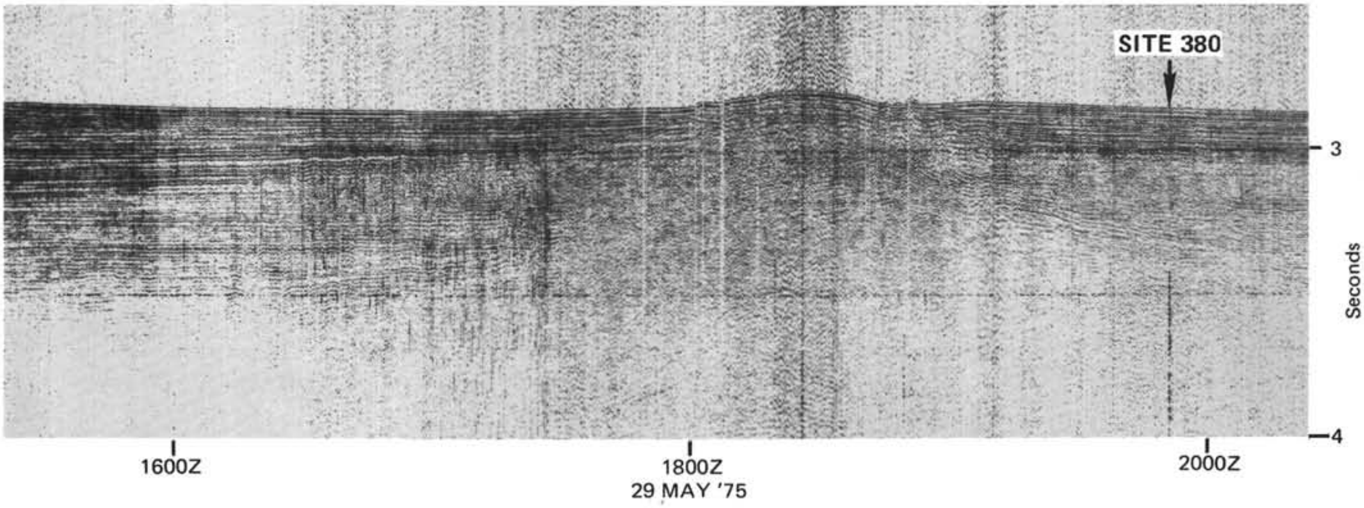


Figure 3. *Seismic profile from deeper abyssal plain area of the central portion of the Black Sea to area of Site 380. Although considerable maneuvering was made before Site 380 was chosen it should be obvious from the figure that there is a thinning of the sedimentary layers going from the deeper parts of the basin towards the flanks.*

TABLE 1
Coring Summary, Site 380

Core	Date (May, June 1975)	Time	Depth From Drill Floor (m)	Depth Below Sea Floor (m)	Length Cored (m)	Length Recovery (m)	Recovery (%)
Hole 380							
1	30	0850	2151.0–2124.5	0.0–9.5	9.5	9.2	97^{a}
2	30	0940	2124.5–2134.0	9.5–19.0	9.5	7.5	79^{a}
3	30	1045	2134.0–2143.5	19.0–28.5	9.5	0.0	0^{a}
4	30	1135	2143.5–2153.0	28.5–38.0	9.5	6.5	68^{a}
5	30	1225	2153.0–2162.5	38.0–47.5	9.5	4.35	46^{a}
6	30	1325	2162.5–2172.0	47.5–57.0	9.5	4.5	$47^{b,c}$
7	30	1415	2172.0–2181.5	57.0–66.5	9.5	3.25	34^{c}
8	30	1610	2181.5–2191.0	66.5–76.0	9.5	1.2	13^{c}
9	30	1718	2191.0–2200.5	76.0–85.5	9.5	1.4	15^{d}
10	30	1827	2200.5–2210.0	85.5–95.0	9.5	5.4	57^{b}
11	30	1930	2210.0–2219.5	95.0–104.5	9.5	0.35	4
12	30	2020	2219.5–2229.0	104.5–114.0	9.5	0.45	5
13	30	2120	2229.0–2238.5	114.0–123.5	9.5	6.85	72^{d}
14	30	2210	2238.5–2248.0	123.5–133.0	9.5	1.8	19^{d}
15	30	2342	2248.0–2257.5	133.0–142.5	9.5	8.1	$85^{b,d}$
16	31	0140	2257.5–2267.0	142.5–152.0	9.5	1.2	13
17	31	0240	2267.0–2276.5	152.0–161.5	9.5	4.3	45^{b}
18	31	0340	2276.5–2286.0	161.5–171.0	9.5	8.65	91^{b}
19	31	0455	2286.0–2295.5	171.0–180.5	9.5	7.3	$77^{b,d}$
20	31	0555	2295.5–2305.0	180.5–190.0	9.5	8.6	91^{b}
21	31	0700	2305.0–2314.5	190.0–199.5	9.5	6.8	72^{b}
22	31	0800	2314.5–2324.0	199.5–209.0	9.5	3.6	38^{b}
23	31	0910	2324.0–2333.5	209.0–218.5	9.5	6.4	67^{b}
24	31	1110	2333.5–2343.0	218.5–228.0	9.5	7.6	80^{b}
25	31	1215	2343.0–2352.5	228.0–237.5	9.5	6.9	73^{b}
26	31	1310	2352.5–2362.0	237.5–247.0	9.5	4.8	51^{b}
27	31	1403	2362.0–2371.5	247.0–256.5	9.5	3.4	36^{b}
28	31	1506	2371.5–2381.0	256.5–266.0	9.5	1.0	11
29	31	1600	2381.0–2390.5	266.0–275.5	9.5	2.1	22^{b}
30	31	1655	2390.5–2400.0	275.5–285.0	9.5	2.4	25^{b}
31	31	1755	2400.0–2409.5	285.0–294.5	9.5	2.35	25^{b}
32	31	1940	2409.5–2419.0	294.5–304.0	9.5	7.0	74^{b}
33	31	2030	2419.0–2428.5	304.0–313.5	9.5	2.5	26^{b}
34	31	2130	2428.5–2432.5	313.5–317.5	4.0	0.0	0^{e}
35	31	2222	2432.5–2438.0	317.5–323.0	5.5	5.0	91
36	31	2323	2438.0–2447.5	323.0–332.5	9.5	3.3	35^{b}
37	1	0035	2447.5–2457.0	332.5–342.0	9.5	2.9	31^{b}
38	1	0145	2457.0–2466.5	342.0–351.5	9.5	3.4	36^{b}
39	1	0300	2466.5–2476.0	351.5–361.0	9.5	5.85	62^{b}
40	1	0420	2476.0–2485.5	361.0–370.5	9.5	1.4	15^{b}
Total					370.5	169.6	45.8

TABLE 1–*Continued*

Core	Date (June 1975)	Time	Depth From Drill Floor (m)	Depth Below Sea Floor (m)	Length Cored (m)	Length Recovery (m)	Recovery (%)
Hole 380A							
1	2	0247	2447.5–2457.0	332.5–342.0	9.5	3.55	37[b]
2	2	0353	2457.0–2466.5	342.0–351.5	9.5	8.0	84[b]
3	2	0505	2466.5–2476.0	351.5–361.0	9.5	7.1	75[b]
4	2	0600	2476.0–2485.5	361.0–370.5	9.5	6.4	67[b]
5	2	0825	2485.5–2495.0	370.5–380.0	9.5	7.6	80[b]
6	2	0945	2495.0–2504.5	380.0–389.5	9.5	4.4	46[b]
7	2	1045	2504.5–2514.0	389.5–399.0	9.5	2.1	22[b]
8	2	1205	2514.0–2523.5	399.0–408.5	9.5	7.3	77[b]
9	2	1320	2523.5–2533.0	408.5–418.0	9.5	7.4	78[b]
10	2	1457	2533.0–2542.5	418.0–427.5	9.5	4.2	44[b]
11	2	1630	2542.5–2552.0	427.5–437.0	9.5	8.1	85[b]
12	2	1740	2552.0–2561.5	437.0–446.5	9.5	8.7	92[b]
13	2	1845	2561.5–2571.0	446.5–456.0	9.5	2.7	28[b]
14	2	2000	2571.0–2580.5	456.0–465.5	9.5	7.0	74[b]
15	2	2250	2580.5–2590.0	465.5–475.0	9.5	6.5	68[b]
16	3	0000	2590.0–2599.5	475.0–484.5	9.5	1.2	13[b]
17	3	0130	2599.5–2609.0	484.5–494.0	9.5	8.75	92[b]
18	3	0315	2609.0–2618.5	494.0–503.5	9.5	4.75	50[b]
19	3	0430	2618.5–2628.0	503.5–513.0	9.5	8.35	88[b]
20	3	0550	2628.0–2637.5	513.0–522.5	9.5	6.4	67[b]
21	3	0700	2637.5–2647.0	522.5–532.0	9.5	6.2	65[b]
22	3	0815	2647.0–2656.5	532.0–541.5	9.5	8.6	91[b]
23	3	0925	2656.5–2666.0	541.5–551.0	9.5	9.1	96[b]
24	3	1040	2666.0–2675.5	551.0–560.5	9.5	0.0	0
25	3	1140	2675.5–2685.0	560.5–570.0	9.5	7.0	74[b]
26	3	1310	2685.0–2694.5	570.0–579.5	9.5	2.7	28[b]
27	3	1430	2694.5–2704.0	579.5–589.0	9.5	8.5	89[b]
28	3	1607	2704.0–2708.0	589.0–593.0	4.0	0.5	13[e]
29	3	1712	2708.0–2713.5	593.0–598.5	5.5	5.3	96[b]
30	3	1840	2713.5–2723.0	598.5–608.0	9.5	3.0	32[b]
31	3	1940	2723.0–2732.5	608.0–617.5	9.5	6.3	66[b]
32	3	2110	2732.5–2742.0	617.5–627.0	9.5	8.7	92[b]
33	3	2210	2746.0–2751.5	631.0–636.5	5.5	3.25	59[b]
34	3	2325	2751.5–2761.0	636.5–646.0	9.5	6.4	67[b]
35	4	0035	2761.0–2770.5	646.0–655.5	9.5	4.75	50[b]
36	4	0147	2770.5–2780.0	655.5–665.0	9.5	5.55	58[b]
37	4	0305	2780.0–2789.5	665.0–674.5	9.5	8.1	85[b]
38	4	0425	2789.5–2799.0	674.5–684.0	9.5	7.65	81[b]
39	4	0540	2799.0–2808.5	684.0–693.5	9.5	3.3	35[b]
40	4	0650	2808.5–2818.0	693.5–703.0	9.5	5.6	59[b]
41	4	0815	2818.0–2827.5	703.0–712.5	9.5	7.6	80[b]
42	4	0940	2827.5–2837.0	712.5–722.0	9.5	8.6	91[b]
43	4	1105	2837.0–2846.5	722.0–731.5	9.5	8.0	84[b]
44	4	1215	2846.5–2856.0	731.5–741.0	9.5	6.0	63[b]
45	4	1420	2856.0–2865.5	741.0–750.5	9.5	8.3	87[b]
46	4	1530	2865.5–2875.0	750.5–760.0	9.5	6.8	72[b]
47	4	1807	2875.0–2884.5	760.0–769.5	9.5	5.5	58[b]
48	4	1930	2884.5–2894.0	769.5–779.0	9.5	6.4	67[b]
49	4	2110	2894.0–2903.5	779.0–788.5	9.5	5.1	54[b]
50	4	2215	2903.5–2913.0	788.5–798.0	9.5	3.7	39[b]
51	4	2359	2913.0–2922.5	798.0–807.5	9.5	9.15	96[b]
52	5	0140	2922.5–2932.0	807.5–817.0	9.5	7.6	80[b, f]
53	5	0302	2932.0–2941.5	817.0–826.5	9.5	5.6	59[b]
54	5	0430	2941.5–2951.0	826.5–836.0	9.5	3.1	33[b]
55	5	0620	2951.0–2960.5	836.0–845.5	9.5	5.2	55[b]
56	5	0810	2960.5–2970.0	845.5–855.0	9.5	4.9	52[b, f]
57	5	0940	2970.0–2979.5	855.0–864.5	9.5	5.1	54[b]
58	5	1115	2979.5–2989.0	864.5–874.0	9.5	4.1	43
59	5	1230	2989.0–2998.5	874.0–883.5	9.5	1.6	17
60	5	1350	2998.5–3008.0	883.5–893.0	9.5	5.0	53[b]
61	5	1545	3008.0–3017.5	893.0–902.5	8.0	0.2	3[b, f]
62	5	1725	3017.5–3027.0	902.5–912.0	9.5	4.1	43
63	5	1842	3027.0–3036.5	912.0–921.5	9.5	5.7	60
64	5	2015	3036.5–3046.0	921.5–931.0	9.5	6.5	68[b]
65	5	2130	3046.0–3055.5	931.0–940.5	9.5	4.0	42[b]

TABLE 1 – *Continued*

66	5	2310	3055.5–3065.0	940.5–950.0	9.5	3.3	35[b, f]
67	6	0035	3065.0–3074.5	950.0–959.5	9.5	2.1	22[b]
68	6	0215	3074.5–3084.0	959.5–969.0	9.5	0.0	0
69	6	0405	3084.0–3093.5	969.0–978.5	9.5	6.5	68[b]
70	6	0615	3093.5–3103.0	978.5–988.0	9.5	6.7	71[b]
71	6	0820	3103.0–3112.5	988.0–997.5	9.5	6.05	64[f]
72	6	1020	3112.5–3122.0	997.5–1007.0	9.5	0.05	1
73	6	1200	3122.0–3131.5	1007.0–1016.5	9.5	5.6	59[b]
74	6	1350	3131.5–3141.0	1016.5–1026.0	9.5	4.3	45
75	6	1515	3141.0–3150.5	1026.0–1035.5	9.5	2.8	29[b]
76	6	1650	3150.5–3160.0	1035.5–1045.0	9.5	6.0	12[b]
77	6	1905	3160.0–3169.5	1045.0–1054.5	9.5	4.1	43[b]
78	6	2115	3169.5–3179.0	1054.5–1064.0	9.5	2.6	27[b]
79	6	2330	3179.0–3188.5	1064.0–1073.5	9.5	2.5	26[f]
Total					735.5	421.45	57.3

Note: 1.2 meters of core was inadvertantly cored while working on hole (referred in places as Core 80).

[a] Punch-in core.

[b] Gassy with some voids.

[c] Coring without circulation.

[d] Broke circulation.

[e] Pressure core barrel.

[f] Added mud.

was drilled to a subbottom depth of 1073.5 meters. We washed down to a depth of 332.5 meters only stopping to take heat flow measurements at 104.5 meters and 171 meters (a third measurement was made at 370.5m). The ninth test of the pressure core barrel was made at 589 meters. The remainder of the section was continuously cored except for 4 meters at 589 and 631 meters and 1.5 meters at 901 meters. The total length of the cored section was 731.5 meters and 421.5 meters were recovered (57.6%). Thus Holes 380 and 380A combined, resulted in a continuously cored section to a total depth of 1073.5. At about 0100 hours on 7 June after pumping 100 barrels of mud, there was an increase in hole pressure suggesting that some of the soft shales may be collapsing around the pipe. This pressure increase had been slowly building over the last 30-40 meters. Torque had increased from 7000 to 11,000 ft-lbs. After several tests, it was decided to pump in a hundred barrels of gel mud, remove the core barrel and end the hole. All surface indications showed that the circulating fluid was being pumped into the formation and not returning up the annulus. Thus it was impossible to keep the hole clean and therefore made abandonment necessary. The abandonment procedure was started at 0500 LCT and pipe was on deck by 1100 LCT.

LITHOLOGY

The two holes at Site 380 penetrated more than 1073.5 meters of a sedimentary sequence. This Black Sea section differs from normal deep-sea sequences in that biogenic components are not important as sediment builders. Only diatoms occur in some abundance sporadically throughout the sections; all other fossils are either rare in occurrence, or insignificant in percentage composition. Also remarkable is the fact that chemical sediments are present, constituting significant portions of the lower half of the penetrated section.

The Quaternary sediments of the Black Sea are distinguished by their high sedimentation rate. The average rate (mainly clastic deposition) is estimated to be about 33-43 cm/10^3 yr, if the beginning of glaciation is dated as 1.5-2 m.y. (Hsü, this volume). Such a rate is comparable to that of the Quaternary section in the Gulf of Mexico (e.g., 38 cm/10^3 at Site 1, Sigsbee Deep, Ewing et al., 1969), and is about an order of magnitude higher than the average rates of pelagic ooze sedimentation in open oceans.

A third remarkable aspect of the Site 380 section (as well as the Site 379 section) is the monotonous, greenish or dark gray colors. A predominantly carbonate section (Unit III) has sufficient pale olive-gray sediments to brighten somewhat the drab color. Only one thin interval (Core 380-40 and its equivalent Core 380A-4) at about 380 meters subbottom has a predominately pale brown color, indicative of the presence of iron in ferric state.

When one examines the section in some detail, it can be seen that it is far from uniform. This thousand-meter-plus section could be divided into some 20 units on the basis of one or another set of criteria. The following parameters have been used in visual and smear-slide descriptions and form the basis for the recognition of sediment-units: color, grain size, composition, sedimentary structures, occurrence of chemical sediments, occurrence of other unusual minerals or sediment types, occurrence of fossils in sufficient amount to be a sediment-builder.

Paleontological information was considered, but was not used as criteria for defining lithostratigraphic units.

We also recognized the problem inherent in any attempt of classification: a subdivision too generalized might eliminate important facets that should not be ignored. On the other hand, to subdivide a section into more than 10 units would place unbearable burdens on the memorial capacity of our readers. These considerations led us to define five units and each unit then subdivided into subunits (see Figure 4), which serve particularly for lithostratigraphical correlations with the sequences at other Black Sea sites. The divisions are in descending order:

Unit I — Terrigenous sediments, including muds, sandy silts, 0-332.5 meters.

Unit II — Various chemical sediments, aragonite, sideritic, and calcitic *seekreide*, interbedded in muds, 332.5-448.0 meters.

Unit III — *Seekreide,* including calcitic oozes and marls, 448-646 meters.

Unit IV — Various chemical sediments, calcitic, sideritic, aragonitic and dolomitic, interbedded in muds, 646-969 meters.

Unit V — Black shales, with dolomite and zeolitic silt intercalations, 969-1074 meters.

Lithological changes are in places transitional where the boundary between units has to be placed at a certain arbitrary horizon. The criteria for division will be discussed where the individual units are described in detail.

Unit I—Terrigenous Sediments (0-332.5 m) Cores 1-35

This topmost division at this site was deposited during a time interval shortly after the beginning of a marine incursion during the Interglacial Stage Anna (see Figure 5) until the present day. The sediments are those present at Site 380 Cores 1 to 35, as well as the sediments in piston cores collected on other expeditions. Dominant lithology is mud in various shades of gray. Intercalated in the muds are silty clay, sandy silts; and, rarely, sands as thin laminae, or very rarely, as thin beds.

The muds, silts, and sands consist of quartz, feldspars, clay minerals, detrital carbonates, and varying amounts of pyrite, heavy minerals, organic matter, and diatoms. As a result of size-sorting, the sands are rich in quartz and feldspar, whereas the clays contain more than 80% clay minerals as detrital grains. The bulk of the sediments are classified as muds. They have a modest amount of silt-sized quartz and feldspars (commonly 5%-15%, and larger amounts of clay minerals (20%-75%. Where silt-sized quartz and feldspar grains are abundant (e.g., >40%), we used the term sandy silts; they commonly occur as laminae. The sandy silts, like the sands, may have been deposited by turbidity currents. The clay minerals are mainly illite and smectite with subordinate kaolinite and chlorite. Detrital carbonates are commonly present, but in small amounts, commonly varying from a trace to 20%.

The muds have an olive hue if they contain appreciable amounts of diatoms (e.g., > 5%). They tend to be dark greenish gray if they contain much pyrite (e.g., > 5%), and they are black if organic matter constitutes more than 10% of the bulk. Silts and sands are gray, and coarse laminae are commonly but not always lighter in color.

The muds are generally structureless, and we found little evidence of burrowing. The bedding is commonly marked by intercalation of silty laminae (or other beds). Cross-lamination is practically absent. Graded bedding is present in thicker and coarser silty or sandy beds.

Unit I includes sediments that were deposited during brief episodes of marine-water influx, and those that were deposited in a fresh to brackish Black Sea draining into the Mediterranean. Chemical sedimentation was insignificant. The division is subdivided into five subunits. They are:

Subunit Ia—Nannofossil Oozes

These are present as a 30-cm layer in Black Sea piston cores, but were not recovered by our coring. This is not surprising as a DSDP drill core very rarely recovers surface sediments.

The nannofossil ooze is a typical sediment of the present Black Sea and has been described in detail by Ross and Degens (1974) as their Unit I.

Subunit Ib—Sapropel (0-2 m) Samples 380-1-1 to 380-1-2, 50 cm

The top of Core 1 is badly disturbed by drilling. It is a dark gray (N-1) mud, rich in organic matter (10%), and diatoms (15%). Its position suggests a correlation with Unit II (sapropel) in Black Sea piston cores, as described by Ross and Degens (1974). However, the sediment sampled for analysis has only 0.60% C_{org} and is, therefore, not a sapropel. The low C_{org} content may be a result of mixing of sapropel and non-sapropelic sediments by drilling disturbances.

Subunit Ic—Muds and Sandy Silts (2-42 m) Samples 380-1-2, 50 cm to 380-5-4, 150 cm

This subunit consists of muds and sandy silts. Core recovery was very poor, and the recovered cores were badly disturbed and include a mixture of greenish gray muds, dark greenish gray sandy silts, and dark gray (N2-N4) sapropelic muds with C_{org} up to almost 1%. We are not certain if the sapropel was in place or a downhole contaminant mixed into the terrigenous sediments during drilling. This subunit is equivalent to Unit 3 at Site 379. The uppermost part of Unit Ic is correlated with Unit III of Black Sea piston cores described by Ross et al., 1973. This subunit Ic represents one of the most sandy intervals at this hole. Silty Sands consist of quartz, feldspar, detrital carbonates, micas, heavy minerals, opaque minerals, clays, and shell fragments. On the whole, the terrigenous sediments here are more micaceous and contain less detrital carbonate than those at Site 379. They were deposited in a fresh-water environment as suggested by the occurrence of fresh-water diatoms (*Stephanodiscus* and *Melosira*) in Core 4 (see Jousé and Mukhina, this volume), mainly during the later part of the Glacial Stage Gamma. The presence of a marine diatom species (*Coscinodiscus kutarin-*

giana) can either be attributed to reworking, or to a brief episode of marine influence. A grapical summary of climatic and other environmental data for this and all the underlying units is included in Figure 4.

Subunit Id—Diatomaceous Mud (45-76 m)
Samples 380-5-4, 50 cm to 380-8 CC

This subunit consists mainly of diatomaceous muds and is probably correlative to the Unit 4 diatomaceous nannofossil mud of Site 379. The top is defined by the first downhole occurrence of diatoms as a sediment-builder in Core 5, Section 4.

The muds are in various shades of olive-gray and contain 10%-25% diatoms. Aside from the usual detrital components, some samples contain up to 10% pyrite. A most interesting minor lithology is a dusty yellow marl. It occurs as numerous thin laminae in Core 7 (Figure 6) and contains 60% carbonate, 25% diatoms, and only 15% terrigenous clastics. Nannofossils occurred in core catchers of Cores 5, 7, and 8. This dusty yellow diatomaceous marl is probably a biogenic sediment; the silt-size calcite grains may represent disintegrated *Braarudosphaera*.

There was a very strong marine influence during the deposition of this unit. Diatoms are characterized as marine (see Schrader, this volume). However, the absence of diversified foraminifers and nannofossil assemblages indicates that condition was never fully normal marine. The occurrence of *Gephyrocapsa* sp. suggests that the salinity of the Black Sea then may have reached more than 18°/00 at times (Percival, this volume; see also Bukry, 1973). The climate was unstable during the accumulation of Subunit Id, a warm interglacial climate was interrupted at least twice by short phases of cold climate (Koroneva and Kartashova, this volume). The oscialltion was sufficiently rapid that the warm interlude was not apparent in the pollen-diagram that used 5-point averages; the tree-pollen dominated flora was thus intepreted as an interstadial stage during the Glacial Stage Gamma (see Figure 1, 2 and 3 Traverse, this volume).

Subunit Id is the first brackish-marine deposit of the Black Sea below the Holocene. Quaternary sections on land include a brackish-marine Karangat Beds, also deposited during an interglacial period, in a similar stratigraphic position. Both the shipboard staff and some shore-based investigators (e.g., Koroneva and Kartashova, this volume) suggest a correlation of the Subunit Id with the Karangat Beds. However, there is no concensus if the period of an unstable warm climate should be correlated (with interruptions of cold phases) to the Eemian or the Riss-Würm Interglacial.

Subunit Ie—Muds (76-142.5 m)
Samples 380-9-1 to 380-15, CC

This is a terrigenous sequence with one diatom-bearing interval (Core 11). The unit is correlative with Unit 6 at Site 379.

The muds are in various shades of gray. Cyclic variations in grain size and color are commonly present (Figure 7). At bottom is a light brown clay; it grades upward into a gray mud, and finally to a black silty mud. The color variation suggests a gradual bottom stagnation as coarser sediments were being deposited. Muds with light brown colors, however, are absent below 95 meters; from there down to 142.5 meters the muds are invariably greenish gray, dark greenish gray, or greenish black.

Organic carbon analyses revealed the presence of several sapropelic horizons, with C_{org} content ranging up to 2.76% (Sample 380-9-5, 50 cm). One of those horizons might be correlative to the 30-cm sapropel unit encountered at Site 379.

The muds and silts sediments have a composition similar to those of Unit 1c, consisting of quartz, feldspar, detrital carbonates, and clay minerals. One interval (Core 11) is diatom bearing; some brackish-water species were identified (Jousé and Mukhina, this volume). Otherwise the depositional environment was believed to have been a fresh-water lake, while the climate changed from warm (Cores 14, 15) to cold (Cores 9, 10, 11) (see Traverse, this volume).

Subunit If—Diatomaceous Muds and Silts (142.4-171 m)
Samples 380-16-1 to 380-18, CC

This subunit is distinguished by the occurrence of diatoms and is correlative to Unit 7 of Site 379. The sediments are greenish gray to dark greenish gray (Figure 8). Diatoms (about 10% by volume) occur mainly in muds. Thin layers of sandy silts are common; they are richer in quartz and feldspar and are commonly devoid of diatoms.

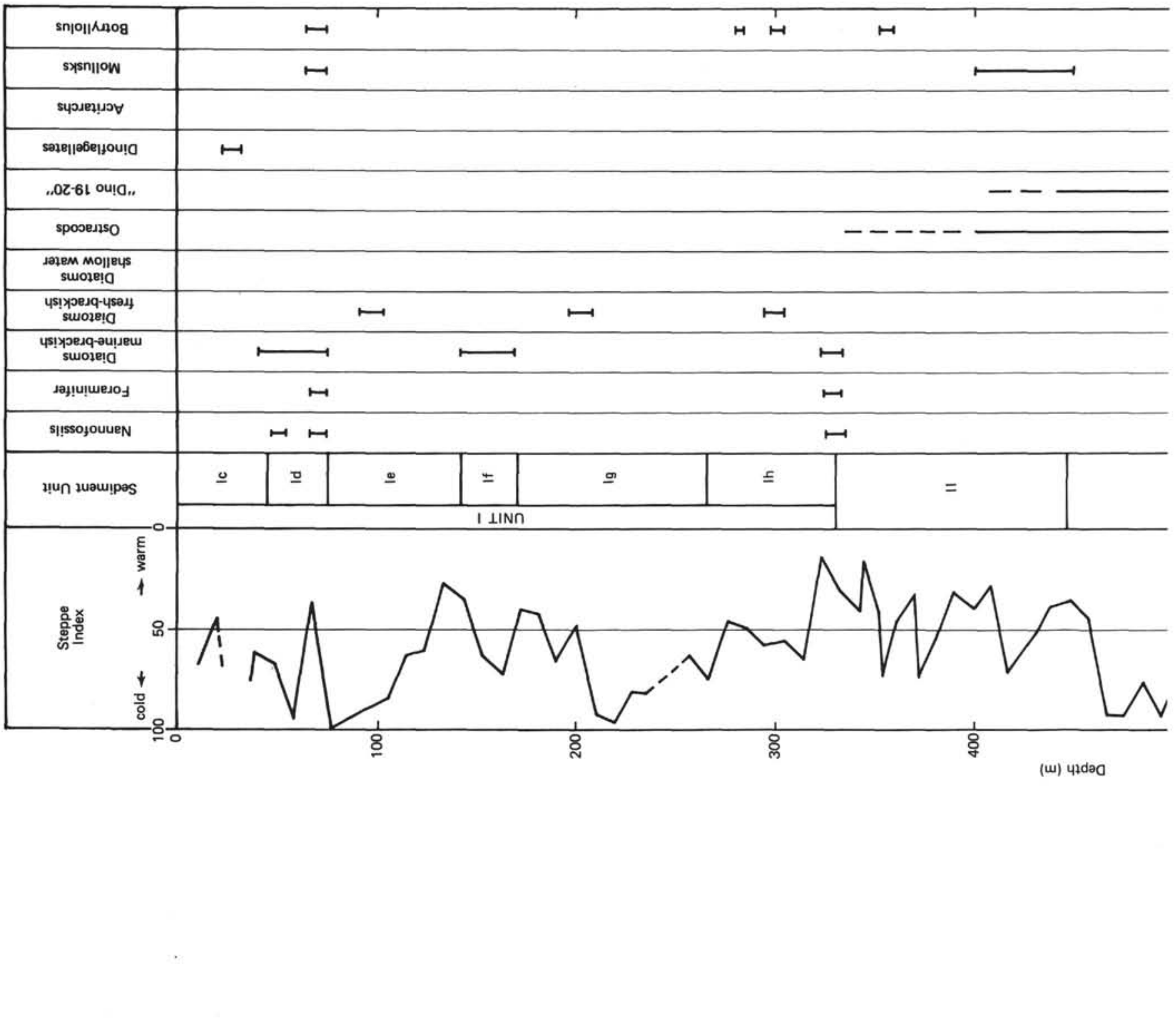
The diatom species present indicate deposition in a brackish-marine condition, with salinity ranges comparable to the present-day Baltic (Schrader, this volume). Pollen floras are generally those from a warm and temperate climate (Koroneva and Kartashova, this volume), although some samples yielded dominantly steppe-flora (Samples 16, CC, 17, CC, see Traverse, this volume).

Subunit Ig—Muds (171-266 m) Samples
380-19-1 to 380-28, CC

This subunit consists mainly of muds and is correlative to the upper part of Unit 8 at Site 379. Thin silt and clay intercalations are common (Figure 9). Also present are several carbonate-rich laminae in Core 25-2. One interval (in Core 22-4) is diatomaceous, and the species are typically fresh water. Similar carbonate-rich laminae and fresh- to brackish diatomaceous horizons are present in the correlative Unit 8 at Site 379. Subunit Ig is similar in lithology to Subunits Ic and Ie and was likewise deposited in a generally cold episode (Beta Glacial Stage, see Traverse, this volume).

Subunit Ih—Muds and Turbidites (266-332.5 m)
Samples 380-29-1 to 380-35, CC

This subunit consists of muds with many turbidite interbeds (Figure 10). The common occurrence of turbidites is a characteristic of the lower half of Unit 8 at Site 379. The first and the last occurrences of the major turbidite beds define the top and the bottom of Subunit Ih here and serve as correlation markers between Sites 380 and 379. Diatoms occur as sediment


Steppe Index
cold
warm
100
50
0
Sediment Unit
Nannofossils
Foraminifer
Diatoms marine-brackish
Diatoms fresh-brackish
Diatoms shallow water
Ostracods
"Dino 19-20"
Dinoflagellates
Acritarchs
Mollusks
Botryllolus
Ic
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If
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Depth (m)

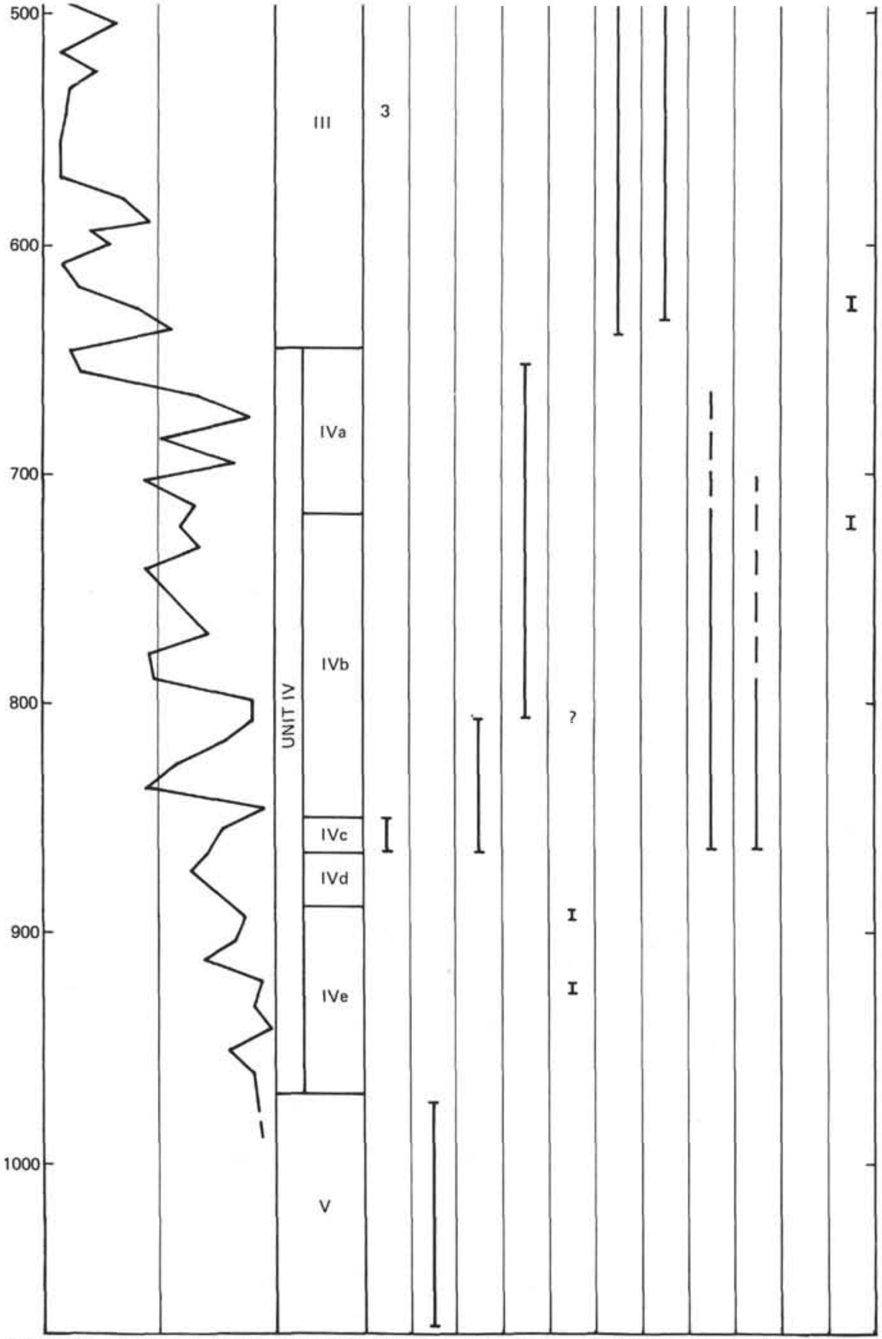


Figure 4. *Climatic and water-salinity changes as recorded by cores at Site 380.*

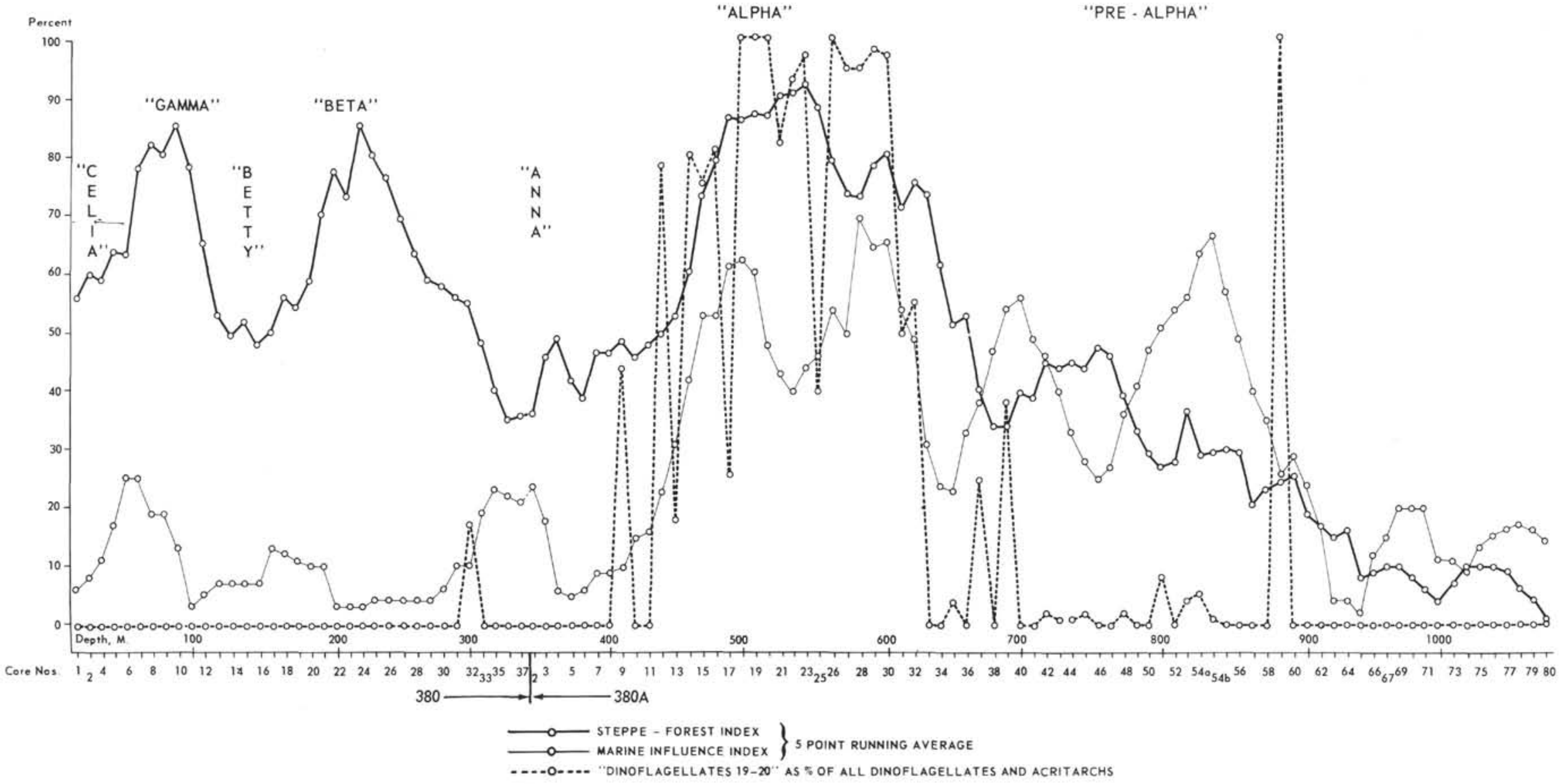


Figure 5. *Basic palynological data, Holes 380 and 380A.*

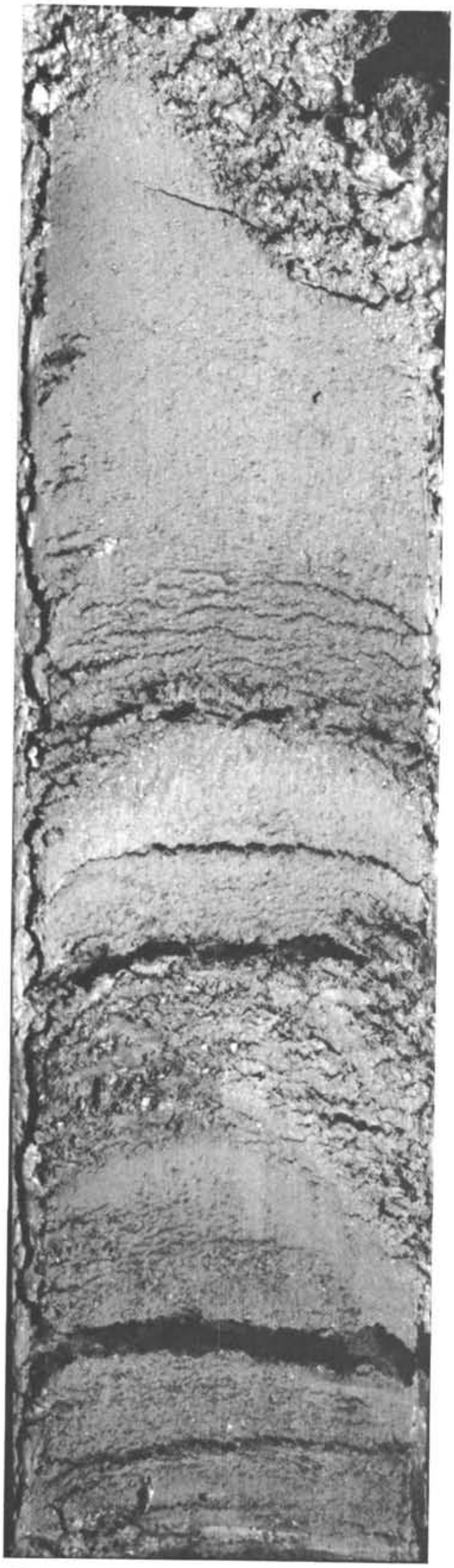


Figure 6. *Mud with laminae of nannofossil marls, Core 7-1, Hole 380, Subunit 1d.*

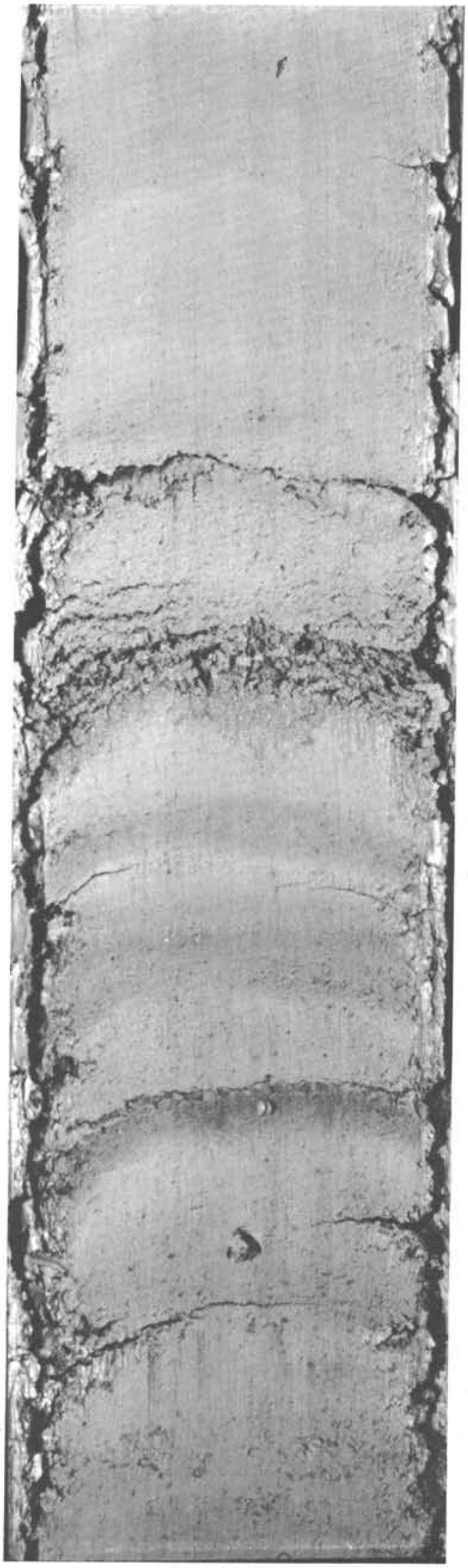


Figure 7. *Mud with cyclic variations in grain size and color, Core 9-1, Hole 380, Subunit 1e.*

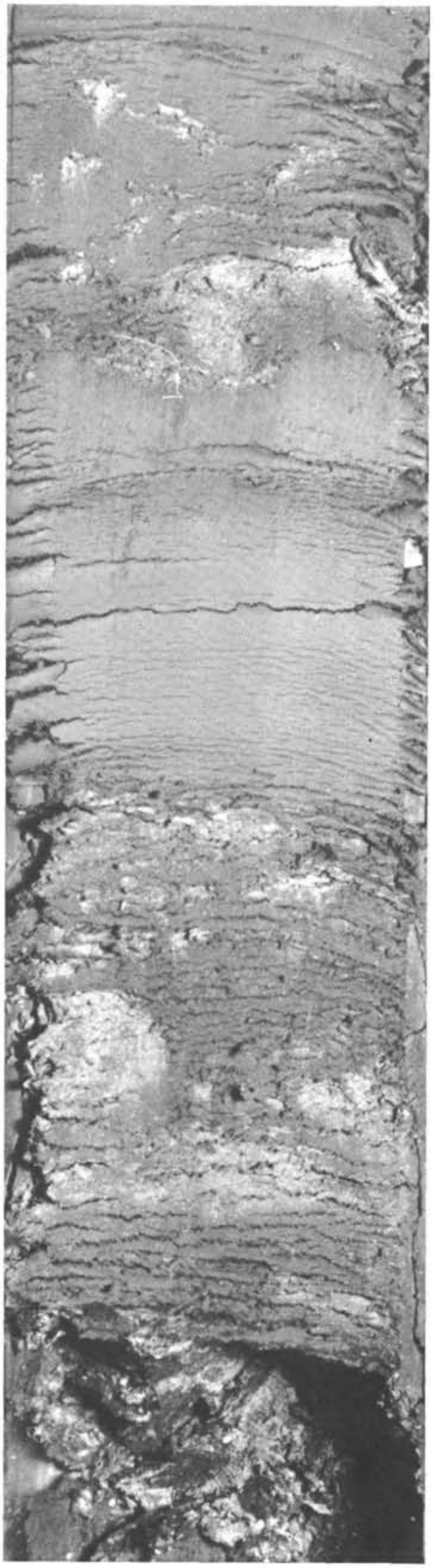


Figure 8. *Diatomaceous mud, Core 10-6, Hole 380, Subunit 1f.*

builders in two intervals: fresh-water species are identified in Core 32, 294.5-304 meters. However, brackish-marine species are present in Core 35, 323-322.5 meters. The presence of an abundant *Ammonia beccarii* fauna in Core 35 samples confirms that the bottommost cores of this subunit were deposited in a brackish-marine environment. Pollen analyses indicate a climatic change from warm (Interglacial Anna) to cold (beginning of Glacial Beta) while the muds and turbidites of this subunit were deposited (Traverse, this volume).

Unit II—Siderite, *Seekreide*, and Muds (332.5-446.5 m) Cores 380-36 to 380-12

This unit is characterized by the numerous intercalations of carbonate-rich layers in a predominately mud sequence. The top of the unit is placed at the top of Core 380-36, which contains aragonitic sediments. The bottom is placed at the bottom of Core 380A-12, which marks the lowest occurrence of siderite-rich sediments in this part of the section.

The unit includes a wide assortment of sediments. Siderite-rich marls are present in thin layers or laminae throughout. Also present are calcareous oozes in which calcite may constitute up to 80% of the sediment bulk. Since their mineralogy and texture are practically identical to the chemical sediments found in perialpine lakes of Switzerland today, we find it convenient to use the Swiss term Seekreide (See, lake, *Kreide,* chalk) to designate such calcite-rich oozes and marls in the Black Sea sediments.

A third chemical sediment is aragonite. In addition to the carbonates, diatomaceous and sapropelic muds, laminated and varve-like clays, as well as sandy silts are present.

The correlation of Unit II with the sediment from Hole 379A is not certain. One of us (KJH) suggested a tentative correlation with the upper half of the Unit 9 there (Cores 379-50-57). Others (ED and PS) believe that this unit was older than Unit 9 at Site 379, and was not reached by drilling. The detailed discussions will be presented in various synthesis chapters (See Hsü, this volume; Degens et al., this volume).

The dominant lithology of the unit are the muds. They consist of quartz, feldspars, clay minerals, and minor amount of detrital carbonates. Their color ranges from greenish gray to olive-gray, or to dark greenish gray; the darker sediments are rich in pyrite whereas the olive or light olive-gray muds contain diatoms or appreciable carbonates. The grain size varies somewhat, but the clay-size ($< 2\ \mu m$) fraction commonly constitutes about two-thirds of the bulk.

The finest terrigenous clastics are varved clays, which may include more than 80% clay-size particles. The varves are interbedded with structureless, 1-2-cm-thick, gray marls in Cores 380A-1 and 4. This laminated sediment is similar to glacial varves. Individual laminae are 1-2 mm thick, with couplets of pale brown silty clay, grading up into a pale olive-gray clay (Figure 11). If they are annual varves, the estimated sedimentation rate would be of the order of 1-2 m/t.yr. However, varve-like, laminated terrigenous sediments of modern Swiss lakes (e.g., Lake of Walenstadt) owe their genesis of fluctuating climatic conditions that are not

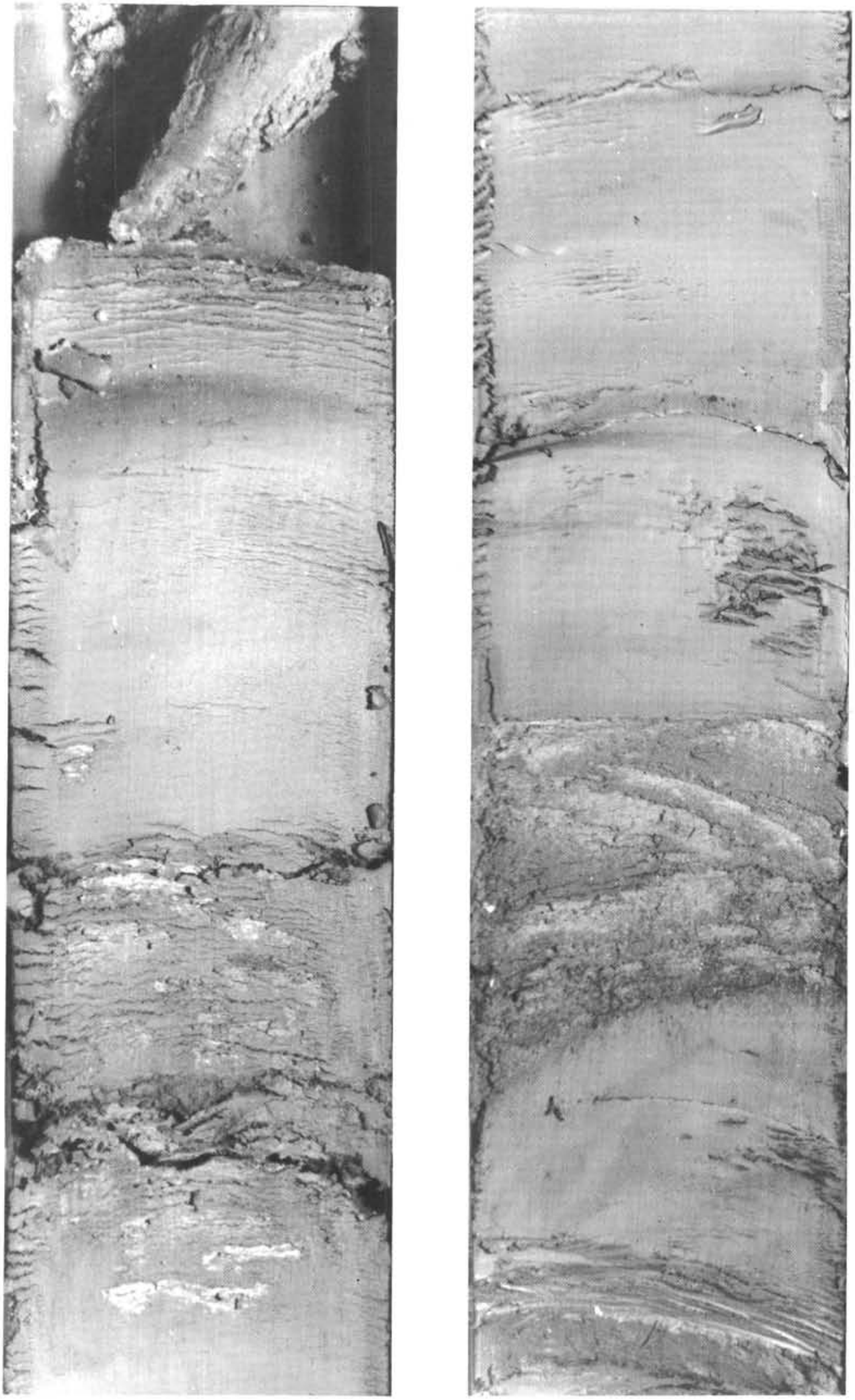


Figure 9. *Silt and clay intercations in mud, Core 22-4, Hole 380, Subunit 1g.*

necessarily annual (Lambert, 1976). Also present in Core 380-1 are two laminae of "nannofossil ooze." The "ooze" must have been detrital in origin, as the nannofossils were identified as reworked Maestrichtian species. Similar laminae of "nannofossil ooze" of a detrital origin have been found in the Lake of

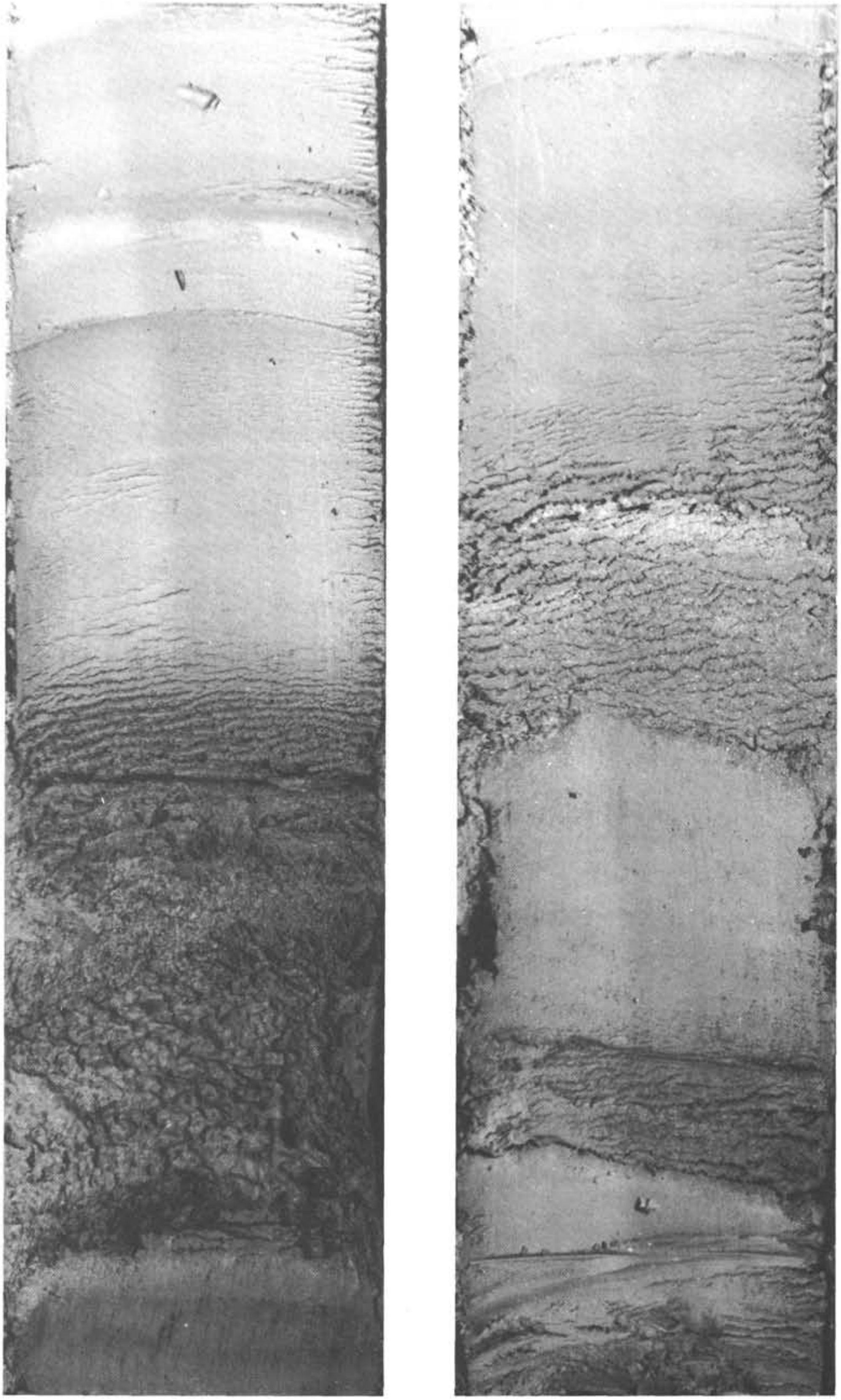


Figure 10. *Turbidite interbeds in mud, Core 31-2, Hole 380, Subunit 1h.*

Walenstadt (Lambert, 1976). The predominately pale brown color of the varve-like interval suggests the existence of iron in ferric state, and a bottom condition considerably less anaerobic than that of the present

Figure 11. *Varve-like detrital sediments, Core 8-3, Hole 380, Unit II.*

Black Sea. Pale brown clays are present in the underlying Core 5, where the sediments are burrowed confirming the interpretation of a sufficiently oxygenated bottom to permit the existence of bottom dwellers then. Sandy silts are scattered throughout the section. Except for a 35-cm turbidite layer (Sample 380A-7-2, 92-128 cm), the silts occur as thin laminae, a few in each section of the core.

Diatomaceous muds and oozes occur only in Core 380A-3 (≈ 380/39). An ooze (Sample 380A-3-4, 142 cm) consists of 70% diatoms, 20% clays, and only 10% other minerals. This ooze is almost the only dominantly biogenic sediment found at this site.

Chemical sediments include aragonite, siderite, and calcite. Needle-like crystals of aragonite are present, either as a chemical precipitate or as an authigenic product, in the muds of Core 36 near the top of the unit. Siderite commonly occurs in marls, which are interbedded with terrigenous muds. They have been found in Cores 380A-1,2,4,6,8,9,11, and 12 and in cores at equivalent levels in Hole 380. The siderite-rich layers are light olive-gray, a few to several centimeters thick (Figure 12). The crystals are mostly silt-sized ($> 2\ \mu$m). Other than siderite, clay minerals constitute the bulk, together with a few percent, or traces, of othe detrital grains and of pyrite.

Calcite-rich marls and oozes, or *seekreide,* are present in Cores 380-39, 380A-1,6,9,10,12. Their calcite content ranges from 20% to 80%. These sediments are interbedded with sideritic marls, but they themselves contain no siderite. Commonly the calcite-rich sediments occur in cycles, such as those described below for the *seekreide* of Unit III. In fact we might consider the interval 408.5-446.5 (Cores 9-12) as a transitional facies to Unit III.

The depositional environment was marine-brackish for the uppermost sediments of the unit. The flood of the *Braarudosphaera* flora in Core 36 suggested a strong marine influence to such an extent that the salinity of the Black Sea may have reached 22$^0/_{00}$ (see Percival, this volume; also Bukry, 1973). The oldest sediments of this unit may have been deposited in a fresh or slightly brackish lake. The transitional facies (Cores 9-12) indicates oscillating environmental changes from a condition favorable for *seekreide*-deposition to one of siderite-formation. Pollen analyses indicate that the climate was in general warm and temperate except for several cold phases. The climate probably was approaching an optimum, when marine waters flooded the Black Sea basin and when the uppermost brackish-marine aragonitic sediments of this unit were deposited.

Unit III— *Seekreide* and Muds (446.5-644.5 m) Samples 380A-13-top to 380A-34-5, 110 cm.

This unit is characterised by the occurrence of *seekreide* in muds. Its upper contact is placed at 446.5 meters; namely at the bottom of Core 380A-12, which still contains siderite or the top of Core 380A-13 which includes a remarkably pure calcitic ooze. The bottom of the unit is placed at 646 meters, just above the diatomaceous ooze (in Core 380A-35-1) of the underlying unit. The correlation to Site 379 is uncertain. One of us (KJH) suggested a correlation to the lower part of Unit 9 at Site 379, in which cyclically deposited sediments are characteristically present. Others (ED and PS) preferred the interpretation that this unit was

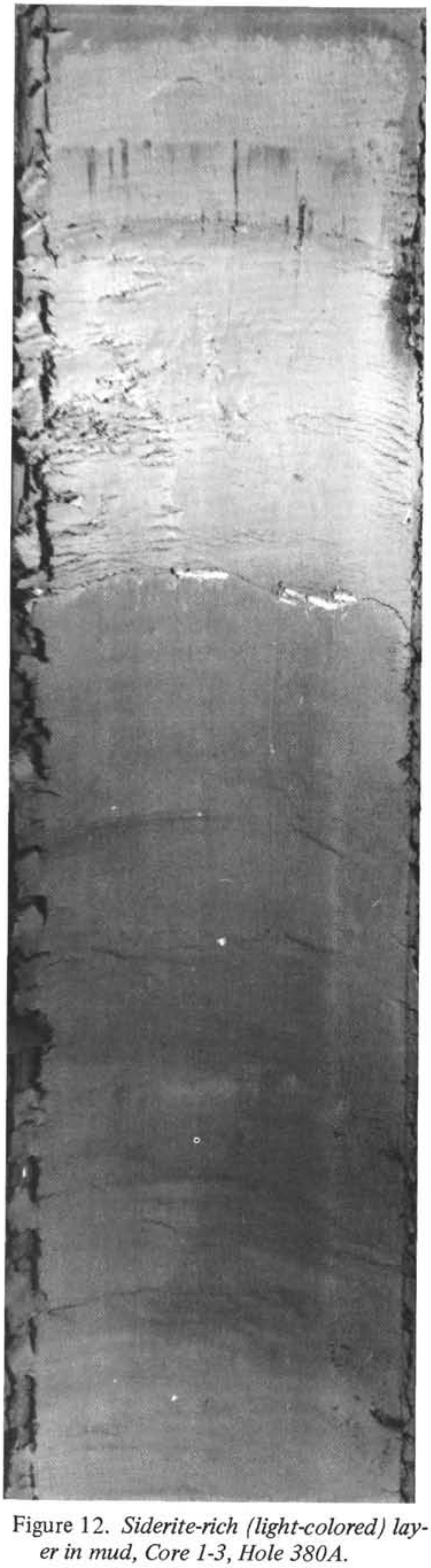


Figure 12. *Siderite-rich (light-colored) layer in mud, Core 1-3, Hole 380A.*

not penetrated at the other site. There is, however, no doubt that Unit III at Site 380 is correlative with Unit 2 at Site 381.

The dominant lithology of Unit III is muds, marls, and *seekreide*. We noted a pattern of cyclic sedimentation, which was first observed in Core 58-4 of Site 379. The cycles range from 2 to 8 cm thick. As shown by Figure 13, a typical cycle is about 4 to 5 cm thick. The base is a medium gray (N-5) mud or marl grading upward into a zone of chondritic burrows. The top is light gray (N-7) calcareous ooze, which consists almost exclusively of silt-sized calcite particles.

Below 540 meters cyclically deposited *seekreide* beds are absent. Instead, the *seekreide* commonly occurs in thin laminations in the form of carbonate varves (Cores 23-34). The carbonate varves consist of light olive-gray, calcareous ooze (75%-80% $CaCO_3$ alternating with greenish gray, organic-rich clays or marls (5%-60% $CaCO_3$).

Whereas the upper 40 meters of the cyclically deposited calcareous oozes are horizontally layered, the rest of the formation includes one or more large slump mass intercalated in horizontally bedded sediments. In examining the features carefully, it seems that some folds, at least, are definitely structures caused by penecontemporaneous slumping, and they are not formed by drilling disturbance (Figure 14). We have interpreted the calcareous oozes as lacustrine chalk, or *seekreide*. It is well known that the *seekreide* is extremely unstable, and subaqueous slumping of *seekreide* is very common phenomenon. The presence of a major unconformity above a thin *seekreide* unit at Site 381 (upslope from Site 380), where large masses of *seekreide* were removed from the region of continental slope, is a proof that slumping did occur. In some intervals centimeters-thick layers of carbonate varves are cyclically alternating with layers of gray muds, in the fashion reminiscent of the cyclic deposition of the non-varved *seekreide* (Figure 15).

Both varved and structureless *seekreide* have been found in Lake Zürich, Switzerland (Kelts, personal communication). The difference in structure may be related to the degree of bottom stagnation. Structureless *seekreide* was formed when the lake bottom was oxygenated sufficiently to permit the existence of burrowing organisms. The carbonate varves of Lake Zürich were deposited after 1895 when the bottom of the lake below the thermocline was eutrophicated and abiotic. The two varieties of the Black Sea *seekreide* may be similarly interpreted. In fact the presence of chondrite burrows indicates the presence of a benthic fauna when the structureless *seekreide* was deposited; the burrows were made by tubificed worms of a kind, which are bottom dwellers of slightly eutrophic lakes (Ekdale, personal communication). The varves on the other hand were deposited when this part of the Black Sea was situated below the thermocline.

The varves in Lake Zürich are deposited annually in response to annual temperature changes; calcite-precipitation takes place every summer when the lake water is supersaturated with $CaCO_3$ (Kelts, personal

Figure 13. *Cyclic sedimentation of* seekreide *(lacustrine chalk) Core 14-3, Hole 380A.*

communication). It is thus probable that the carbonate varves in the Black Sea are likewise annual. The carbonate laminae in those varves are commonly less than 1 mm thick, giving a sedimentation rate less than 1 m/t.yr. The cycles in the scale of centimeters are, however, unlikely to be seasonal. Geothermal considerations would rule out the possibility of such high sedimentation rate. The cycles probably reflect climatic changes.

Unit III sediments contain an ostracode fauna including abundant fragments and some whole shells. The *Candona-Loxoconcha* assemblage indicates deposition in deep, fresh-water lakes (Benson, this volume; Olteanu, this volume). Associated with the ostracode fauna is a dinoflagellate nicknamed *Bag 51* on account of its bag-like form and its first downhole occurrence in Core 51 at Site 379. It is probably a new species of fresh-water habitat. This dinoflagellate is abundant in all samples down to 532 meters (Cores 380A-13-21), and is extremely abundant in Samples 380A-14, CC, 15, CC, 18, CC, and 30, CC. Associated with those microfossils are "oddballs" which are probably jaws of water fleas. The ecological significance of those fossils are uncertain, but they were probably creatures living in deep fresh-water lakes on account of their association with the ostracode fauna. Diatoms are practically absent but for two occurrences in Cores 380A-17 and 32. The *seekreide* unit was deposited during the Alpha Glacial Stage, there was some interstadial amelioration of climate. *Botryococcus,* a warm-climate indicator, occurs in Sample 380A-15, CC. Diatom occurrences may also coincide with warmer interlude in an overall glacial climate.

Unit IV—Chemical Sediments, Muds, and Coarse Clastics (644.6-969 m) Samples 380A-34-5, 110 cm to 380A-168, CC

Unit IV, like Unit II is characterized by the occurrence of a wide variety of sediment types, including various chemical sediments. Its top is defined by a siderite layer at 664.6 meters (Sample 380A-34-5, 110 cm). The base is transitional to an underlying black shale with the boundary placed at the bottom of Core 380A-69, or 969 meters. Below this horizon black shales are the dominant lithology. Unit IV is characterized by the presence of diatoms as a sediment builder (diatoms are present in muds ranging from 5% to 60% down to 950 m), and by the frequent intercalations of carbonate-rich sediments. Also noteworthy is the existence of pebbly mudstones and breccias, which constitute Subunit IVd. This thick formation is subdivided into five subunits.

Subunit IVa — Sideritic and Diatomaceous Sediments (644.6-718 m) Samples 380A-34-5, 110 cm to 380A-42-4, 50 cm)

This subunit is characterized by the occurrence of numerous manganosiderite intercalations in a

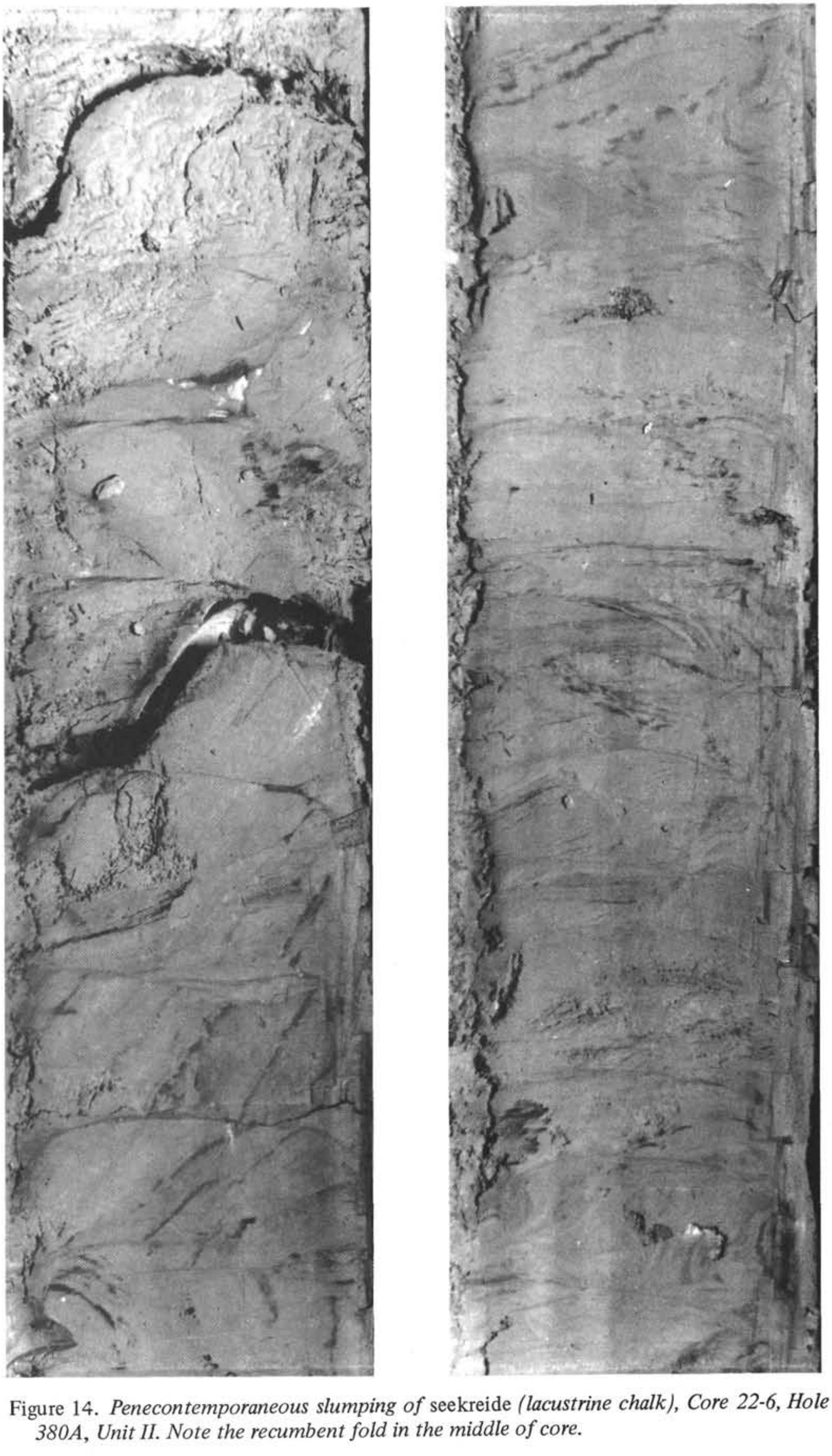


Figure 14. *Penecontemporaneous slumping of* seekreide *(lacustrine chalk), Core 22-6, Hole 380A, Unit II. Note the recumbent fold in the middle of core.*

Figure 15. *Carbonate-varves, Core 31-2, Hole 380A, Unit II, irregular layering might be caused by drilling disturbance.*

predominantly diatomaceous clay. Siderite layers defined the top and the bottom contacts. This subunit is correlative to Unit 3 at Site 381.

The dominant lithology is not mud, but a diatomaceous clay; the terrigenous components are finer in this subunit than those in overlying sediments. Clay-size particles commonly range from 60% to 80% of the bulk. The clay beds are on the whole structureless in the upper part, but some very distinct laminations are present in the lower part. The structureless clay beds consist mainly of clay minerals with various amounts of diatoms, ranging from 15% to 60%. Quartz is present in minor amounts (2%-15½), and feldspars are rare or absent. Carbonate minerals, except for a trace of detrital carbonates, are practically absent in the clays. The dominant clay mineral is smectite, with illite subordinate and minor amounts of kaolite and chlorite. The laminated sediments consist of couplets of diatom-rich and clay-rich laminae, each a millimeter or less in thickness. The lighter laminae are invariably diatom-rich and may contain as much as 80% diatoms, whereas the darker are clay-rich (85%), with only 10% or 15% diatoms (e.g., Sample 380A-41-5, 141.0-141.1 cm). These laminated sediments may be referred to as diatom-varves. Diatom-rich sediments are common in modern fresh-water lakes, such as Lake Zürich. However, diatom-rich layers are not necessarily annual accumulations. Studies of Lake Zürich sediments revealed the occurrence of diatom-rich laminae in years of periodic blooms (Kelts, personal communication). Diatoms do occur as a biogenic component in carbonate varves of Lake Zürich, but the Black Sea diatom varves are on the whole carbonate free.

Siderite is the characteristic mineral of this unit. This siderite is richer in manganese than that in the upper sideritic sediments of Unit II, the Mn-content ranges from 1% to 7% (Stoffers, this volume). Also the sideritic sediments are invariably hard, whereas the upper siderite occurs mainly in soft marls and muds. Sediments rich in siderite (40%-60%) are pale olive in color; they are present as thin layers, or as nodules (Figure 16) in Cores 380A-34, 36, 37, 39, 40, 41, and 42.

A few layers of light olive-gray diatomaceous Seekreide are present near the top of the unit (Core 35); transitional to Unit III. They are intercalated in an olive-gray organic-rich clay (Cores 35, 36). Pyritic clays devoid of diatoms are also present as a minor lithology. Finally, two tuff laminae were identified in Core 380A-37-5 and in Core 380A-41-3.

The depositional environment was probably oscillating from fresh to brackish, as indicated by the habitat of the diatom species present (Schrader, this volume). Dinoflagellates occur in abundance in Core 37, spicules in Cores 38 and 39, and otoliths in Core 40. Those occurrences suggest one or more episodes of marine influx. Pollen analysis indicates that the prevailing climate was warm and temperate except for the time when the uppermost (Core 380-35) *seekreide*-bearing sediments were deposited.

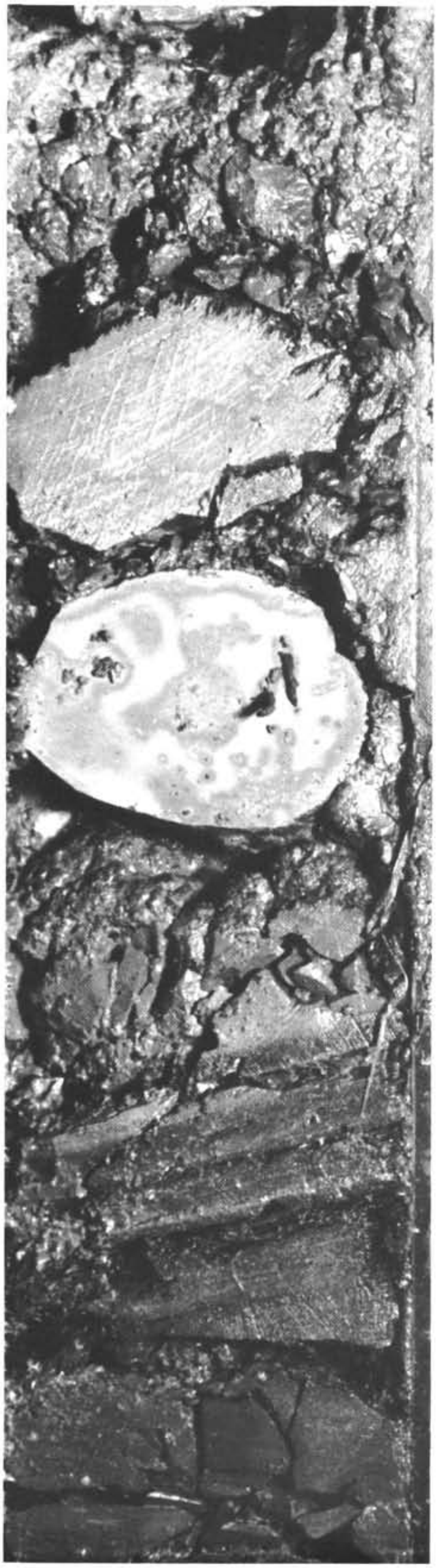


Figure 16. *Siderite nodule in mud, Core 40-5, Hole 380A, Unit IV.*

Subunit IVb—Laminated *Seekreide*, laminated Diatomite, Diatomaceous Marls (718-850.3 m)
Samples 380A-42-4, 50 cm to 380A-56-4, 35 cm

This subunit is devoid of manganosiderite intercalations, and instead, *seekreide* is an important constituent. Also present are diatomaceous clays, and marls, structureless or laminated (Figure 17). The top of the subunit is defined by the base of the siderite in Core 380A-34-5, and the bottom by the uppermost occurrence of aragonite in Sample 380A-56-4, 35 cm. This subunit is correlative to Unit 4 at Site 381.

Three major sediment builders are clays (terrigenous), calcite (chemical), and diatoms (biogenic). They occur in various proportions in various laminated and structureless sediments. In Seekreide varves, the laminated sediments include a calcite-rich light greenish gray lamina and a clay-rich dark greenish gray lamina; diatoms are, as a rule, rare or absent in those carbonate varves. In diatomite varves, the laminated sediments include a light olive-green calcite-bearing diatomaceous marl, and a darker olive-green carbonate-free diatomaceous clay. The varves occur as layers one or a few centimeters thick (Figure 18). Interbedded with the varves are structureless sediments several centimeters thick that are commonly marls or diatomaceous marls, containing clay minerals, calcite, and diatoms in various proportions; diatomaceous clays are also present, but far less common. In parts of the section the interbedding of laminated and structureless sediments give the appearance of cyclic deposition (Figure 19). Cycles alternating light and dark beds with chondritic burrows in transition range from 2 to 8 cm thick. They resemble the cyclical deposition of *seekreide* in Unit III and in lower part of Unit II, except for the latter, *seekreide* are not laminated and rarely contain diatoms.

Samples of laminated carbonate were observed under the scanning microscope. The light laminae consist mainly of well sorted, silt-sized crystals (5-15 μm) of calcite, where the clay minerals predominate in the darker laminae. Diatoms are present in both, showing signs of considerable dissolution. This carbonate varve is thus mineralogically and texturally identical to the carbonate varve formed in Lake Zürich today. The structureless marls contains, in addition to clay minerals, 30%-50% calcite, and a few to more than 10% diatoms. Similar structureless sediments were accumulating in Lake Zürich prior to its eutrophication of 1895. However, structureless marls and laminated *seekreide* do not form cycles of centimeters-scale in modern Swiss lakes.

The sediments of this unit were deposited during a time-interval when chemical precipitation of calcite repeatedly took place. Dinoflagellates and acritarchs are present throughout this sequence, very abundant at the base, becoming less common toward the top. Diatom floras also changed from a marine-brackish ("Baltic") in Cores 381A-52-56 to a more nearly fresh water assemblage in Cores 380A-42-48. Pollen analysis indicates a period of generally warm and temperate climate, with some temperature fluctuations (pre-Alpha Stage, see Traverse, this volume).

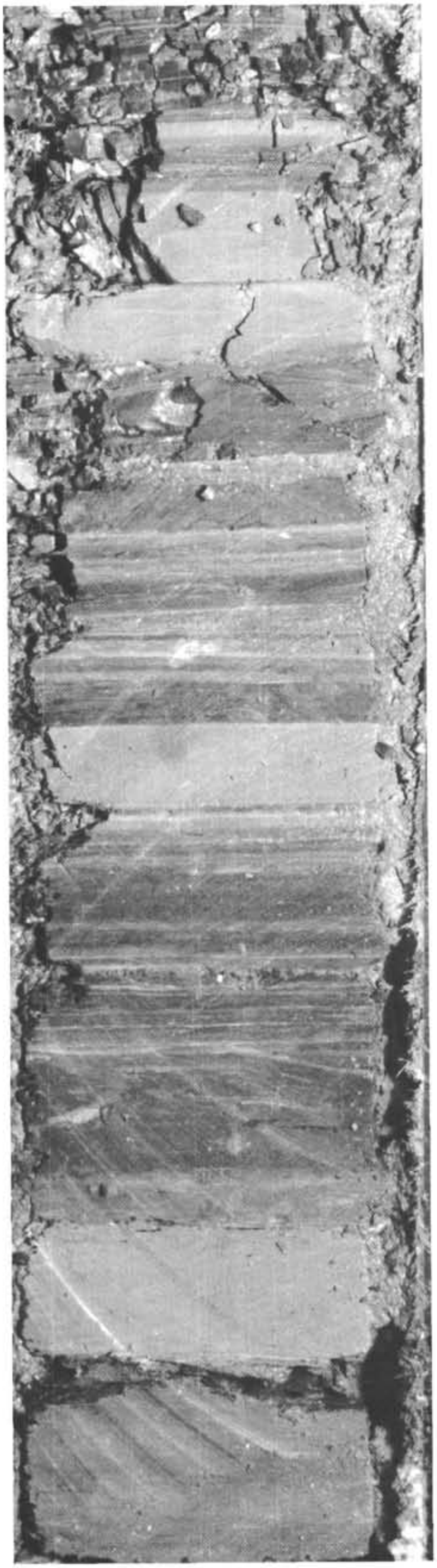


Figure 17. *Laminated diatomaceous clays and marls, Core 47-2, Hole 380A, Sub-Unit IVb.*

Figure 18. *Layers of laminated diatomaceous sediments, Core 52-2, Hole 380A, Subunit IVb.*

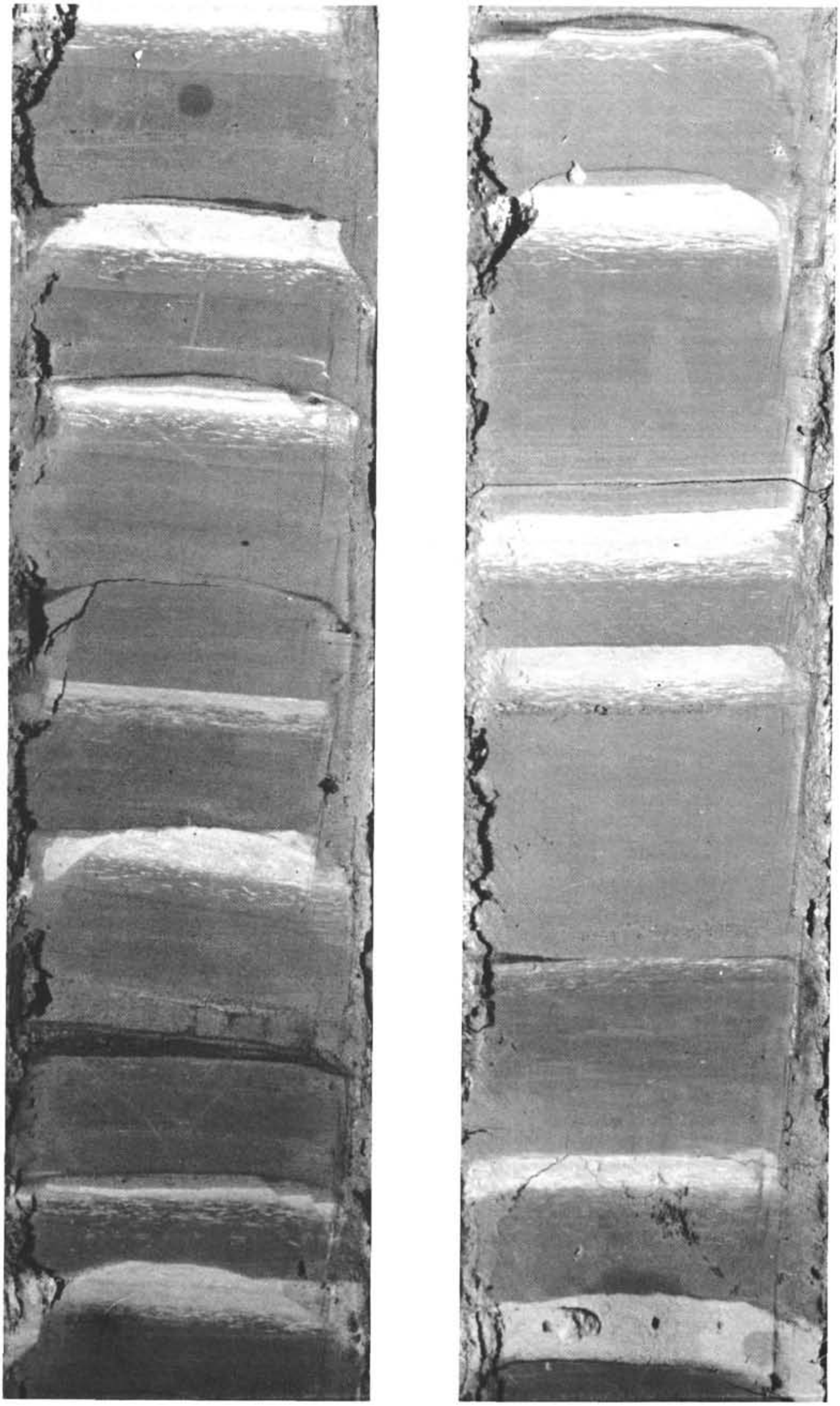


Figure 19. *Cyclically deposited* seekreide *(lacustrine chalk), Core 51-3, Hole 380A, Subunit IVb.*

Subunit IVc — Laminated Aragonite, Diatomaceous Shale (850.3-864.5 m)
Samples 380A-56-4, 35 cm to 380A-57 CC

The subunit is characterized by the presence of aragonite and magnesian calcite as chemical sediments. The top occurrence of aragonite marks the top of the interval. Its base is placed at the contact between laminated carbonates in Sample 380A-57, CC and pebbly mudstone in Sample 380A-58-top. This subunit is correlative to Unit 5 at Site 381.

The dominant lithology is diatomaceous shales that are olive-black (5Y2/1) in color. Some are carbonate-free like those in the underlying Unit V, others are marly, containing some 10% to 20% carbonate, similar to some in Subunit IVd.

Intercalated in the shales is aragonite (Figure 20). Those may either have an overall dark ("black varves") or light appearance ("white varves"). Smear-slide studies show that the color difference reflects a composition difference. The carbonate content of the light laminae in a "black varve" is only about 25% and that in "white varves" ranges from 60% to about 90%. The carbonate is aragonite, or a mixture of aragonite and magnesian calcite. Diatoms are practically absent in laminated carbonates. A slump deposit, overlain by graded beds, 70 cm thick is present in Sample 380A-57-1.

The sediments of this subunit were deposited in a brackish marine environment. The abundant *Braarudosphaera* nannoflora indicates that the salinity may have reached in excess of 22% (Percival, this volume; see also Bukry, 1973). The presence of a dwarfed ("oligotypic") *Bolivina* microfauna also signifies stenohaline conditions (Gheorghian, this volume). Other indicators of marine influence, such as dinoflagellates and acritarchs are also very abundant. The climate was then warm and temperate (Traverse, this volume).

Subunit IVd — Coarse Clastic, Stromatolitic Dolomite (864.5-883.5 m)
Sample 380-58-top to 380A-59-CC

This subunit includes some of the most unusual lithology of the Black Sea sediments: pebbly mudstones, stromatolitic dolomites, and cobble-clasts of conglomerates. This subunit is correlative to Unit 6 at Site 381. The most remarkable sediment is the horizontally laminated, stromatolitic dolomite (Sample 380A-58-3, 130-150 cm; Figure 18). The dolomite was formed in an environment similar to that of an intertidal to supratidal zone (see Stoffers, this volume). That the water level was probably very shallow in the Black Sea basin at, or about, that time was also suggested by the finding of diatoms of very shallow habitats in Cores 380A-60 and 64 of the underlying subunit (Schrader, this volume).

The dominant lithology of the subunit is, however, a coarse clastic, which has been variously referred to as conglomerate, slump breccia, or pebbly mudstone (Figure 21). It will be referred to as a "pebbly mudstone" because the deposit consists largely of

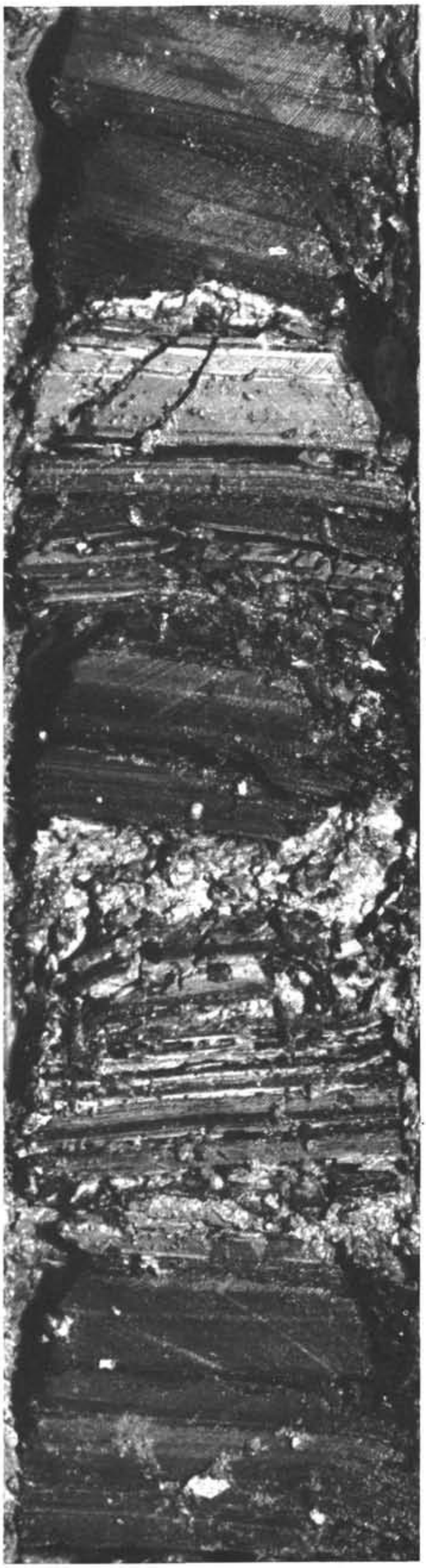


Figure 20. *Aragonite sediments Core 57-6, Hole 380A, Subunit IVc.*

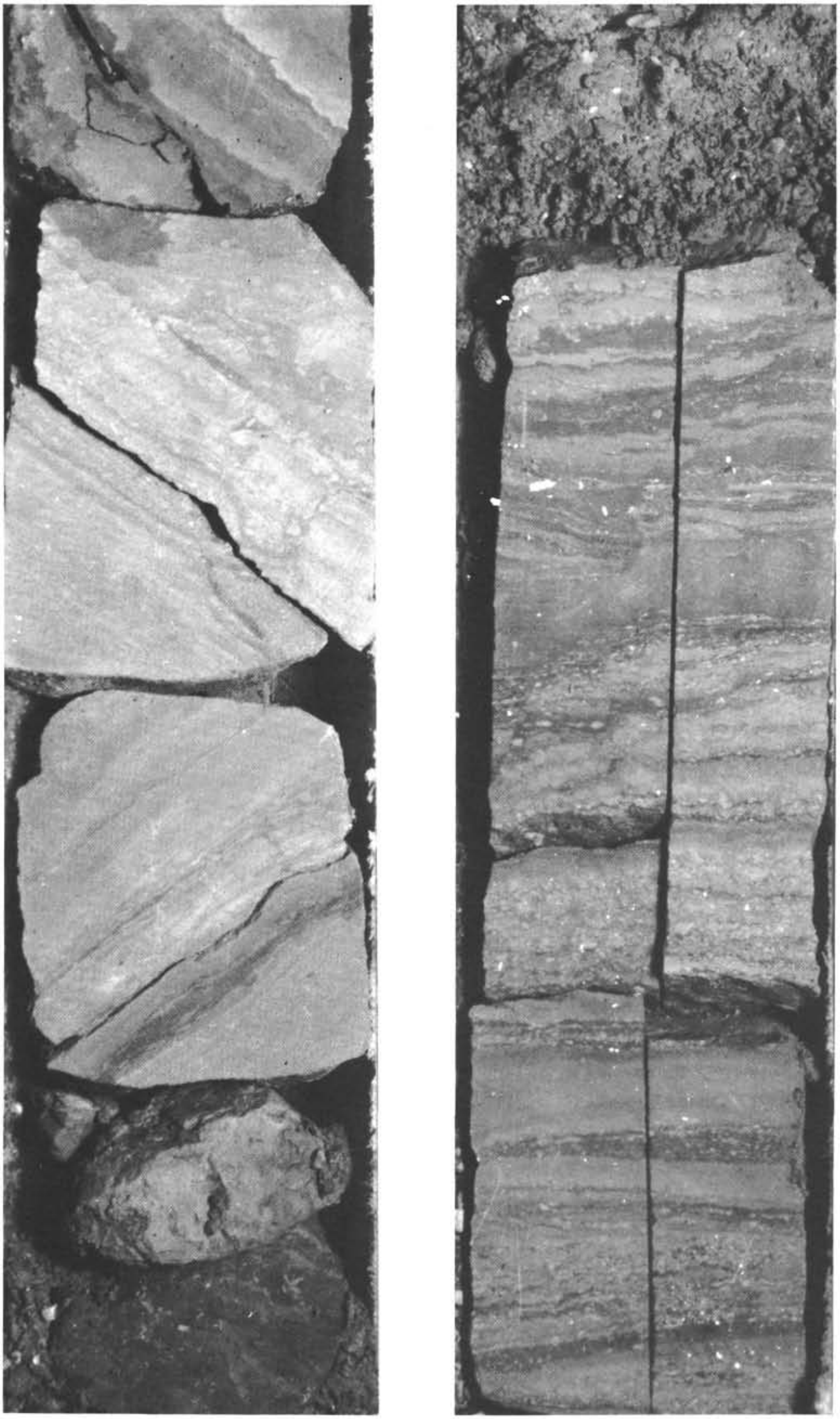


Figure 21. *Stromatolic dolomite, Core 58-3, Hole 380A, Subunit IVd. The blocks with steep dips may be allochthonous.*

pebble-size clasts in a dark gray mudstone matrix. However, it differs from the ordinary pebbly mudstones in that its clasts include many angular fragments; hard, angular clasts are commonly dolomite. A large-sized clast found in Sample 380A-58-3,94-112 cm, with the bedding surface within the clast now inclined at 50 degrees, is lithologically identical to the underlying, horizontally bedded, stromatolitic dolomite (Figure 22). We can safely conclude that the clast was ripped off from the dolomite deposit and was transported for very short distance when it was embedded in the matrix of the "pebbly mudstone." Hard dolomite fragments of smaller size are scattered throughout the "mudstone" as clasts. Also present as clasts are firm, but not lithified muds or marls. Those clasts are smaller and are angular to subrounded.

The genesis of the "pebbly mudstone" is not certain. It may have been deposited subaqueously when the water level of the Black Sea basin was rapidly raised by a marine influx, which brought in the marine-brackish faunas and floras now fossilized in the immediately overlying sediments.

Subunit IVe — Laminated *Seekreide*, Marls, and Dolomite (838.5-969 m)
Samples 380A-60-top to 380A-68-CC

This subunit is characterized by the presence of dolomite in a sequence of laminated *seekreide* and marls (Figure 23). The lithology is similar to Subunit IVb except for the intercalations of dolomite-rich layers. The top of the unit is in contact with the base of the "pebbly mudstone." The relation to the underlying Unit 5 is transitional and is placed at the base of Core 380A-68, below which the dominant lithology (black shale) is practically devoid of carbonate. Sediments typical of this subunit are not recognized below the "pebbly mudstone" unit at Site 381: the correlation between the two sites is uncertain.

The dominant lithology is a calcareous mud, or marl, dark greenish gray in color, and structureless except for some burrows (Figure 23). Intercalated in the dominantly marly sequence are aragonitic, calcitic, and dolomitic sediments. These chemical sediments occur in various proportions in three distinct sediment types:

1) Laminated marl: This laminated rock has a varve-like appearance and has been referred to as "black varve" (in contrast to carbonate-rich "white varve"). The dark laminae are olive-black and consist mainly of clays (85%), with some quartz, feldspar, pyrite, and detrital carbonate. The lighter laminae are commonly greenish gray, and are carbonate rich (Figure 24).

2) Carbonate varve: This laminated sediment is also varve-like, like the *seekreide* varves in Units III and IVb (Figure 23). However, the calcium carbonate in this subunit is not always calcite; aragonite, in fact, is common. The carbonate content in the light laminae varies from 50% to 100%; the darker laminae are greenish gray and are richer in clay.

3) Dolomite: Almost pure dolomite, pale olive-gray in color, occurs as thin layers a few cm thick, and is not laminated.

We counted the number of varves in several intervals. In Core 380-63, we recognized 81 couplets of "white varves" in a 7.2 cm interval, giving a maximum sedimentation rate of 0.9 m/10^3 year if the varves are annual.

Figure 22. *Pebbly mudstone, Core 59-1, Hole 380A, Subunit 4d.*

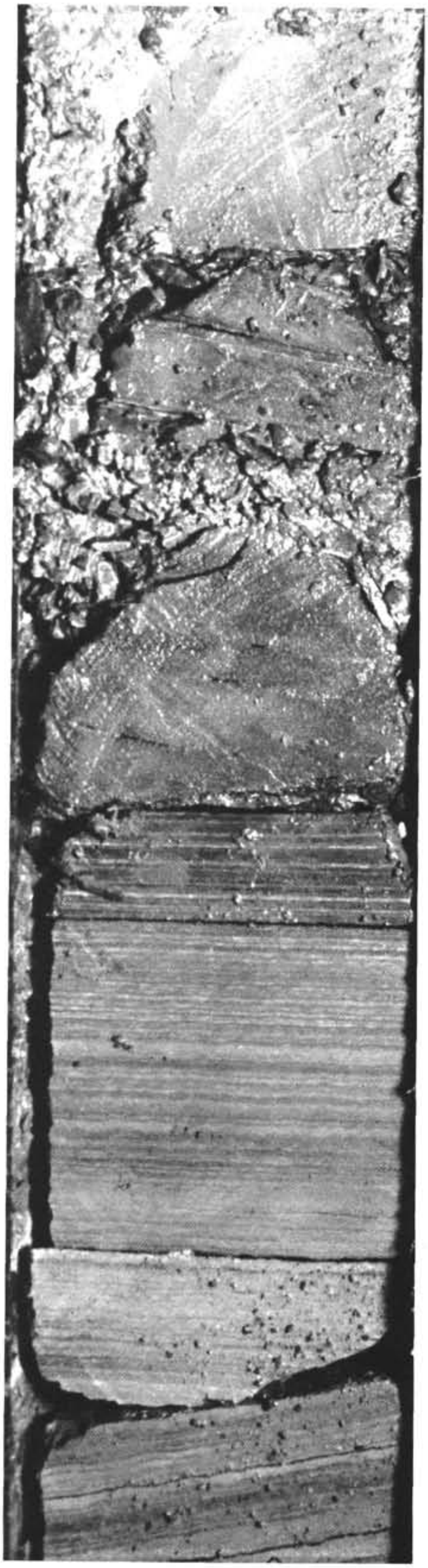


Figure 23. *Laminated* seekreide *(lacustrine chalk), Core 63-3, Hole 380A, Subunit IVe.*

"Black varves" have thinner couplets and were probably deposited at slower rate.

Except for pollens and spores, fossils are rare in the sediments of this unit. Diatoms are rare or absent. Diatoms in Cores 60 and 64 suggest a shallow-water depositional environment (Schrader, this volume). Siliceous spicules of unknown affinity were found in Cores 61 to 66. On the whole there was little or no indication of marine influence. Pollen analysis yielded few cold-climate indicators, warm indicators are larger numbers of *Ulmaceae,* and regular records of *Carya* and *Pterocarya* (Traverse, this volume).

Unit V—Black Shale, With Dolomite Laminations (969-1073.5 m) Samples 380A-69-top to 380A-80

The unit consists of black shales, with zeolitic sandstones and dolomite. In the uppermost trasitional interval to the overlying formation some "black" and "white" varves are present as intercalations (Cores 69,70).

The black shales are greenish black and fissile. They consist of clays, rich organic matter, and may contain up to 20% quartz and feldspars, 10% pyrite, and are practically devoid of carbonates. The dolomite is almost 90% pure, and occurs as laminations several millimeters thick (Figure 25), or as thin-layers a few centimeters thick.

Dolomite is quantitatively insignificant constituting less than 1% of the cored interval. Tuffaceous and zeolitic siltstones and sandstones are either cross-stratified laminae, or graded. A typical graded bed (Sample 380A-73-1, 124.5-127 cm) is a few centimeters thick. The top is a dark gray pyrite-rich clay (80% clay, 10% pyrite), grading downward to a medium dark gray silty clay (30% quartz plus feldspars, 60% clay). The base is commonly a sandy siltstone or sandstone (85% quartz and feldspars, 5% ash and zeolites, 10% heavy minerals). The silty sediments are common in Core 380A-73-3; 10 such layers are present in a 40-cm interval. The presence of tuffaceous sediments testifies to the activity of nearby volcanos.

The black shales and associated sediments were deposited in a brackish-marine environment, as indicated by the presence of a small benthic foraminifer throughout the sequence. The flora suggested a warm climate. Palm pollens, along with Sequoia, are present. The bottommost core contains a richly diverse subtropical to warm-temperate flora, with *Liquimdambar, Engelhardtia,* along with Palmae (Traverse, this volume). The pollen record suggests that sediments of this unit are mostly missing at Site 381, only the lowest sediment of this unit, Core 380A-80 is correlative with the uppermost of the *Engelhardtia*-bearing sequence at Site 381 (Units 2, 8, 9). Stratigraphical studies of the foraminiferal faunas support this tentative correlation (Gheorghian, this volume). The age of this unit is most probably late Miocene.

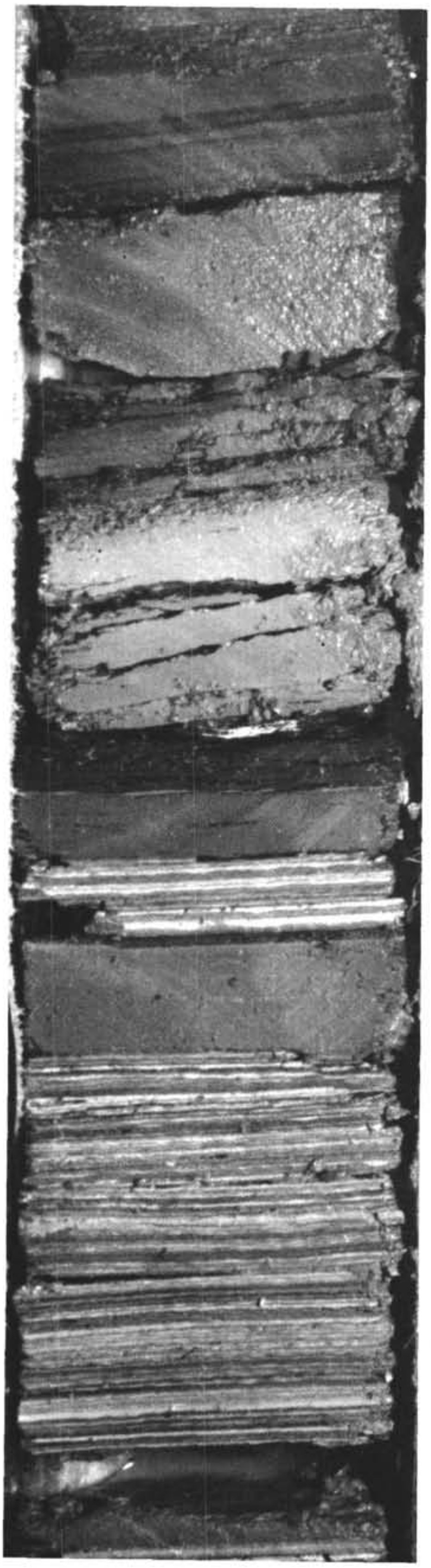


Figure 24. *Laminated marl, Core 65-1, Hole 380A, Subunit IVe.*

Figure 25. *Black shale with intercalated dolomite-laminae (light-colored), of Core 20-3, Hole 380A, Subunit V.*

BIOSTRATIGRAPHY

Calcareous Nannoplankton in Site 380

One hundred twenty-three samples were examined for calcareous nannoplankton for purposes of age dating, zoning, and making paleoenvironmental interpretations. Most samples contained only reworked Cretaceous and Eocene to Oligocene species of calcareous nannoplankton. Two intervals, Core 2 through Core 10 and Core 36, had indigenous species (see Table 2). The first interval is dominated by an abundance of *Gephyrocapsa caribbeanica* Boudreaux and Hay. Frequencies range from barren to floods through this interval. Core 2 through Core 10, Section 2, 27-29 cm, are assigned to a Quaternary age based on the range of *G. caribbeanica.* The paleoenvironment is interpreted as having been brackish water based on the absence of normal marine species listed by Bukry (1974).

The second interval consists of three samples from Core 36: (380-36-2, 77-79 cm, 380-36-3, 82-84 cm, and 380-36, CC). They contained very rare whole and fragmented specimens of *Braarudosphaera bigelowi* (Gran and Braarud) without accompanying indigenous species, although reworked Cretaceous and Eocene to Oligocene forms are present. *Braarudosphaera bigelowi* is useless for age determinations and zoning since it has a range from Jurassic to Recent; however, it can be used for making paleoenvironmental interpretations. According to Bukry (1974) a nannoflora comprised only of *B. bigelowi* is indicative of a brackish-water depositional environment.

Other Groups—Site 380

One hundred twelve samples were examined for planktonic foraminifers for age dating, zoning, and paleoenvironmental purposes. No indigenous planktonic foramifers were observed in any of the samples. Four samples (380-2-1, 105-107 cm, 380-5-1, 103-105 cm, 380-6-1, 133-135 cm, and 380-8-1, 87-89 cm) were found to contain very rare to rare small (juvenile) globigerinids. One sample (380-4-2, 92-94 cm) contained a small (juvenile) globorotalid and another, (380-6-1, 133-135 cm) contained a specimen of *Pseudohastigerina* sp. The latter occurrences are reworked species. Estimates of the frequencies of other groups of organisms were recorded during the process of searching for planktonic foraminifers (Table 2).

Benthic foraminifers are primarily restricted to the upper eight cores (Table 2). The nine fossiliferous samples in this interval are dominated by *Ammonia beccarrii* (Linne). Also present in some samples are *Ammonia viennensis* (d'Orbigny). *Elphidium crispum* (Fitchtel and Moll) and *Protoelphidium martkobi* (Bogdanovicz). The remainder of the cored interval is barren except for two intervals. The first of these intervals is Sample 380-14, CC where a very rare benthic foraminifer fauna is present. The second is the interval represented by Core 35 through the upper part of Core 36. Two samples (380-35-3, 49-51 cm and 380-35, CC) contain an abundant fauna dominated by *Ammonia beccarii* with associated rare occurrences of other species. Samples 380-35-4, 58-60 cm and 380-36-2, 82-84 cm contain a very rare benthic foraminifer fauna. A detailed analysis of the benthic foraminifers is presented by Gheorghian (this volume).

Diatoms are somewhat sporadically distributed throughout the cored interval (Table 2). Their occurrences are restricted to samples from Core 1, Cores 4 through 8, Cores 10 through 12, Cores 16 through 18, Core 21, Core 22, Cores 32 through 36, and Core 39. Their frequencies vary from barren to floods. The only interval characterized by floods of diatoms is represented by Cores 5 through 8. Separate detailed descriptions of the floras are presented by Jousé and Mukhina and Schrader (this volume).

Ostracodes are distributed throughout much of the hole with Cores 17 through 19 and 29 through 31 being the only barren intervals. Frequencies of specimens range from very rare to frequent. The results of detailed studies of selected samples are given by Olteanu (this volume), as are the results of a more complete study by Schneider; a preliminary report is also given by Benson.

Molluscs occur in high abundance (abundant to floods) in Cores 1 through 7, in lesser frequencies (very rare to frequent) in Cores 8 through 15, and in even lesser frequencies (very rare to rare) in Cores 20 through 23 (Table 2). The intervals from Cores 16 through 19 and 24 through 34 are barren of molluscs. Two samples (380-35-3, 99-101 cm and 380-35, CC) contain floods of molluscs; Cores 36 and 37 are barren. The interval from Cores 38 through 40 contains very rare to common molluscs.

Siliceous spicules appear to be sporadically distributed, being concentrated in Core 1, Cores 5 through 11, Cores 15 through 22, and Cores 32 through 39. The frequencies range from very rare to floods. The remainder of the cored intervals are barren of siliceous spicules. The only other microfossils are floods of fish remains in Sample 380-36, CC.

Calcareous Nannoplankton—Hole 380A

Two hundred nineteen samples were examined for calcareous nannoplankton for assigning age, and making zonal interpretations, and paleoenvironmental interpretations. Most samples contained only reworked Cretaceous and Eocene to Oligocene calcareous nannoplankton species. The only interval which contained indigenous calcareous nannoplankton is from 380A-55, CC through 380A-57, CC (Table 2). In that interval only four samples (380A-55, CC 380A-56-4, 136-138 cm, 380A-56, CC, and 380A-57, CC) out of the nine samples examined had fragmented and whole specimens of *Braarudosphaera bigelowi* (Gran and Braarud). Although reworked Cretaceous and Eocene to Oligocene species were present, no other indigenous species were present. The frequencies of *B. bigelowi* range from rare to floods. This form survived from Jurassic times to the present and therefore cannot be used as an age indicator. However, it can be used for an interpretation of the paleoenvironment. Bukry (1974) suggests that nannofloras comprised only of *B. bigelowi* indicate brackish-water deposition.

Other Groups—Hole 380A

Two hundred seventeen samples were examined for planktonic foraminifers for purposes of making age determinations, zonal determinations, and paleoenvironmental interpretations. No indigenous planktonic foraminifers were found. Five samples contain reworked globigerinids (380A-9, CC, 380A-12, CC, 380A-15, CC, 380A-28, CC, and 380A-60, CC). These are separately reported by Gheorghian (this volume). Estimates of the frequencies of other microfossil groups were also made during the process of searching for planktonic foraminifers (Table 3).

Benthic foraminifers occur rarely and sporadically above the interval represented by Cores 70 through 78 (Table 3). They were observed in 11 samples (380A-3, CC, 380A-9-6, 54-56 cm, 380A-9, CC, 380A-12, CC 380A-23, CC, 380A-28, CC, 380A-32, CC, 380A-40, CC, 380A-55, CC, 380A-57, CC, and 380A-60, CC). Most of the occurrences are of very rare reworked benthic forms (see report by Gheorghian, this volume). The last three samples contain *Elphidium* spp., some of which he feels are derived from the Miocene. For more details the reader is referred to his report in another section. In the interval from Cores 70 through 78, eight samples (380A-70, CC, 380A-71-3, 72-74 cm, 380A-71, CC, 380A73, CC, 380A-74, CC, 380A-76, CC, 380A-77, CC, and 380A-79, CC) contain very rare to abundant benthic foraminifer faunas.

Diatoms are most abundant in the interval from Core 34 through Core 57 (Table 3). Throughout most of the remaining interval they are absent, except they occur in floods in Cores 3, 4, and 63, are frequent in Core 66, rare in Core 60, and very rare in Core 64. The diatoms are described more fully in separate studies by Jousé and Mukhina and Schneider (this volume).

Ostracodes constitute an important part of the fauna from Cores 3 through 34 (Table 3). Ostracodes occur frequently in Cores 53 and 76, they are rare in Core 51, and very rare in Core 54. A complete analysis of the ostracodes is given by Schneider, an analysis of selected samples by Olteanu, and a preliminary report by Benson (all this volume).

Molluscs are sporadic in their distribution in the cored interval (see Table 3). They are present in Core 2, Cores 4 through 13, Cores 15 through 16, Cores 25 through 29, Cores 31 through 33, Core 55, Core 57, Cores 60 through 61, and Core 76.

Siliceous spicules are primarily restricted to the interval from Cores 33 through 58, although they occur in Cores 3, 4, 17, the interval from Cores 61 through 66, Core 69, and Core 78. The only other microfossils found are calcispheres? and fish remains. Calispheres? are abundant in Samples 380A-70, CC, 380A-73-1, 94-96 cm, 380A-75, CC, and 380A-76, CC, frequent in 380A-73-3, 72-74 cm and rare in 380A-73-2, 54-56 cm and 380A-74, CC. Fish teeth are very rare in Samples 380A-48-5, 96-98 cm, 380A-48, CC, and 380A-53-4, 42-44 cm. Fish remains are abundant in 380A-55-3, 68-70 cm, common in 380A-60-4, 59-61 cm, and rare in 380A-54-2, 42-44 cm. Otoliths are common in 380A-76, CC, frequent in 380A-71-3, 72-74 cm, rare in 380A-73-3, 72-74 cm, 380A-76-4, 102-104 cm, and 380A-78, CC, and very rare in 380A-57, CC and 380A-75, CC.

PALYNOLOGY

All core-catcher samples recovered, Cores 1-40 of Hole 380, and Cores 1-80 of Hole 380A, were analyzed palynologically. Shipboard extraction techniques consisted of prolonged heating in Calgon detergent, and a float-sink procedure with $ZnCl_2$ solution, specific gravity 2.0. Shore procedure was the same, except that 52U HF digestion was substituted for detergent dispersion. This produced cleaner and more concentrated residues, but an interesting aspect of the shipboard work was that acceptable preparations were obtained from all samples without the use of HF.

The palynofloras obtained consisted of pollen, embryophytic spores, fungal spores, algal remains, acritarchs, and dinoflagellates. The gross palynological results for Site 380 are displayed in Figure 4.

"Steppe-Forest Index" (SFI) as a general climatic indicator, was calculated for each core-catcher sample, using the following ratio:

$$\frac{\tfrac{2}{3}\ \textit{Artemisia} + \text{Chenopodiaceae} + \text{Amaranthaceae}}{\text{(The above)} + \textit{Pinus} + \textit{Cedrus} + \textit{Picea} + \textit{Abies} + \textit{Quercus} + \textit{Alnus} + \text{Ulmaceae (and other tree genera)}}$$

The larger the number obtained, the more indication of comparatively cool/dry conditions in the Black Sea drainage. Modern surface sediments of the Black Sea yield a SFI of about 10%.

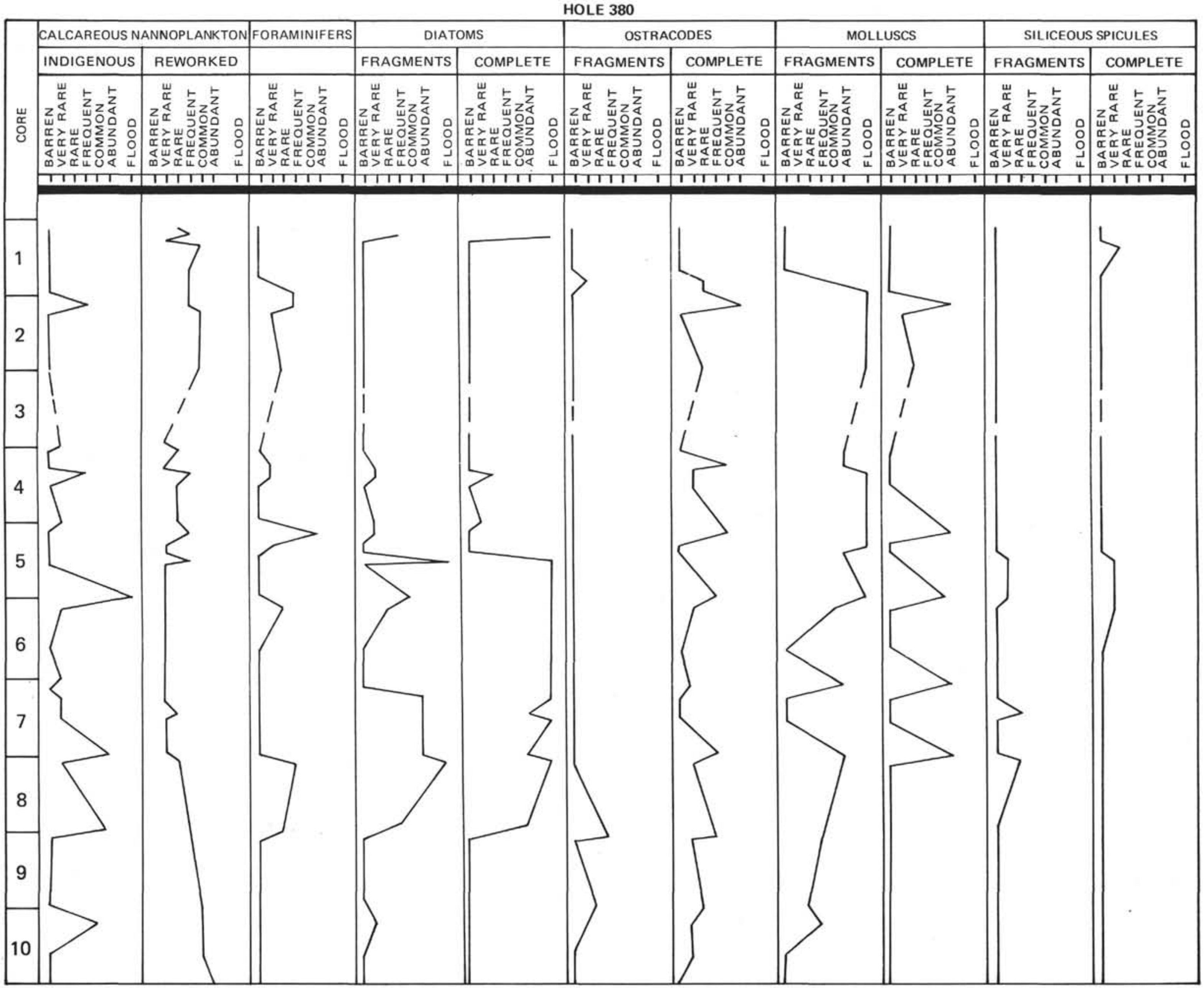
A "Marine-Influence Index" (MI) was calculated as the following ratio:

$$\frac{\text{Dinoflagellates} + \text{Acritarchs}}{\text{Dinoflagellates} + \text{Acritarchs} + \text{Total Pollen}}$$

Note, however, that some dinoflagellates are fresh-water forms, and "acritarchs," while presumably algal, are by definition a heterogenous group of unknown exact relationship, and presumably include fresh-water forms. Even the modern Black Sea is far from fully marine and yet surface sediments produce a high (ca. 40%) MI. A very low MI does indicate fully non-marine environment, however. One especially characteristic baglike dinoflagellate, as yet unnamed ("dinoflagellates 19-20"), is plotted separately as a percent of dinoflagellates and acritarchs because its appearance in the record is characteristically sudden and dramatic. (This fossil was known as "bag 51".)

Shipboard palynological analyses demonstrated that Core 1 of Hole 380A was equivalent to Core 37 of Site 380. A more complete record was penetrated and therefore the SFI obtained is taken as the standard of comparison for Sites 379 and 381. The three major steppe peaks shown (called "Alpha," "Beta," and "Gamma" to avoid implication of identity with already named Pleistocene units) are taken to represent cool periods when a larger proportion of the Black Sea drainage area was dominated by cool/dry loving plants than is true today. "Pre-Alpha," "Anna," "Betty," and "Celia" represent warmer periods when forest trees dominated the drainage area to an extent equal to or greater than the present. The "Alpha" cool period is also characterized by large numbers of acritarchs and dinoflagellates, as shown by the high MI values. This demonstrates that salinity *could* increase in the Black

TABLE 2
Distribution of Various Fossil Groups in Hole 380 at Site 380 (RW=reworked)



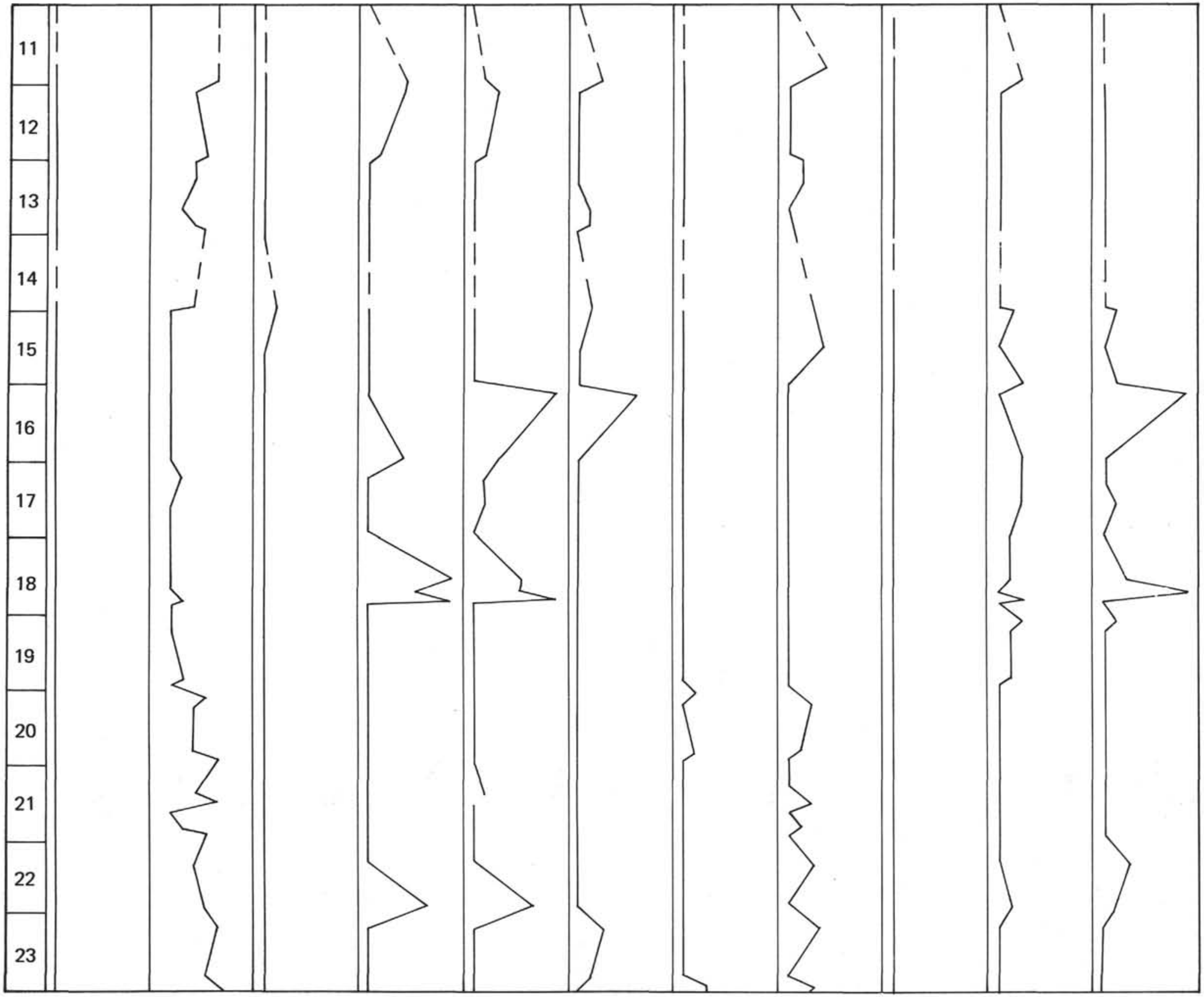

11
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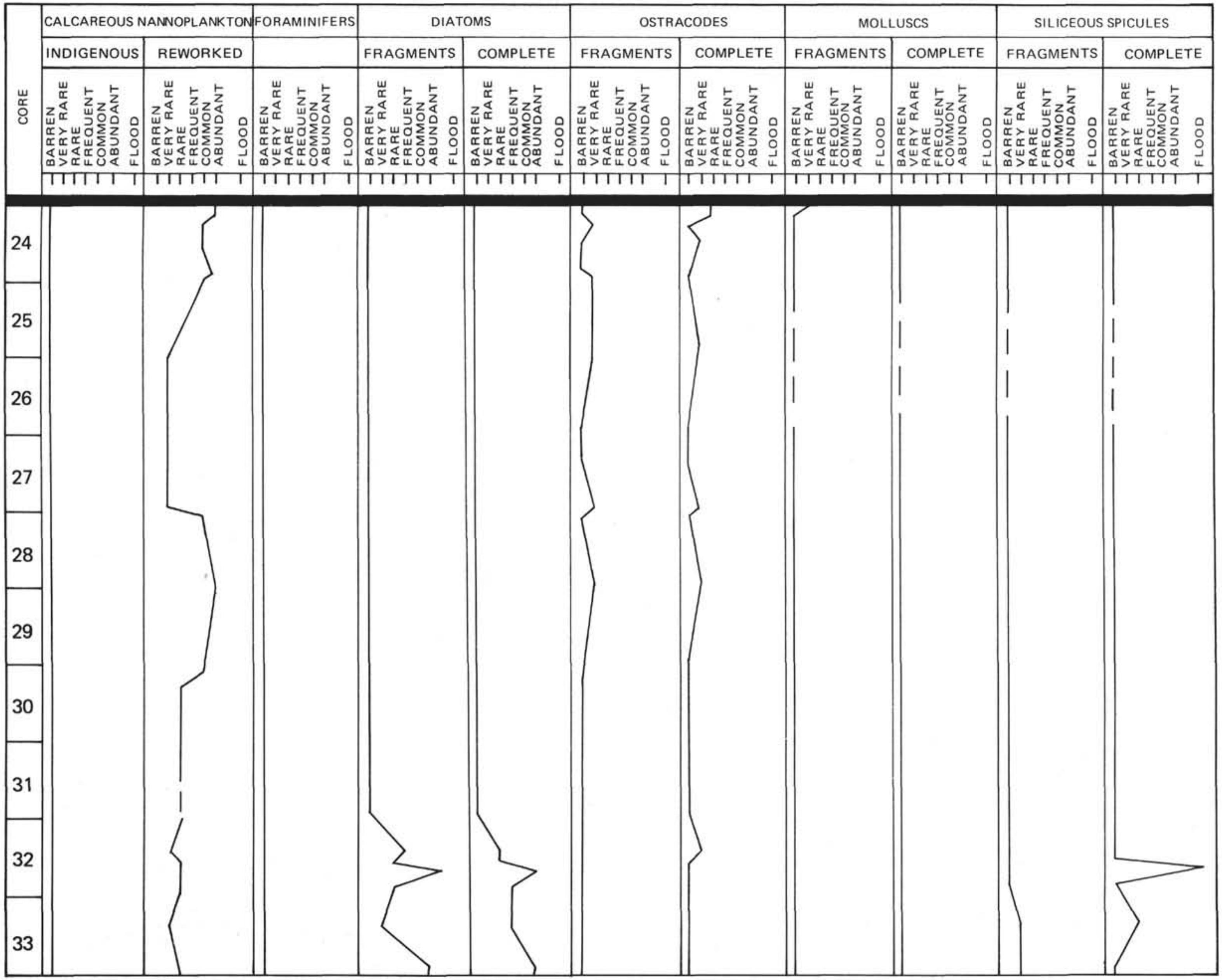
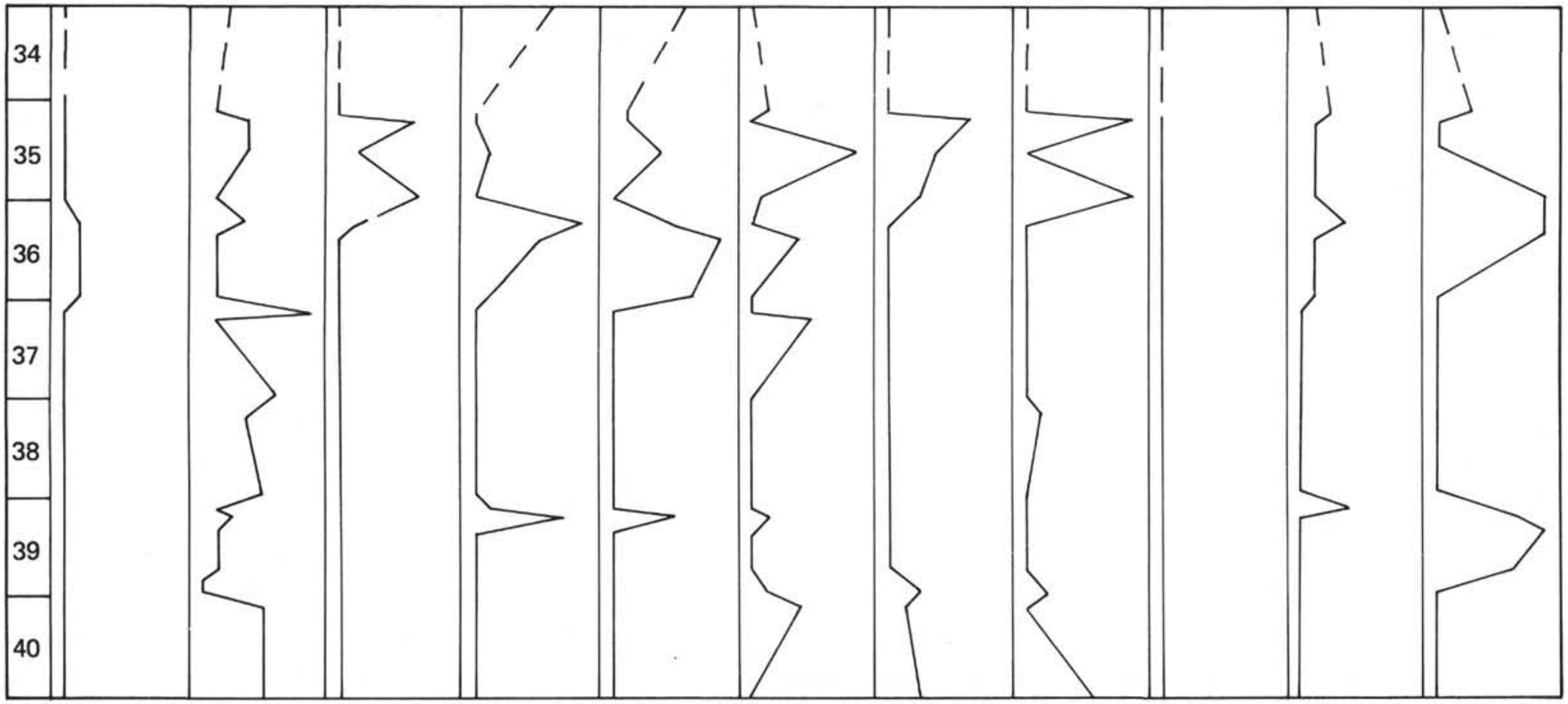
TABLE 2 – *Continued*

HOLE 380




34
35
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37
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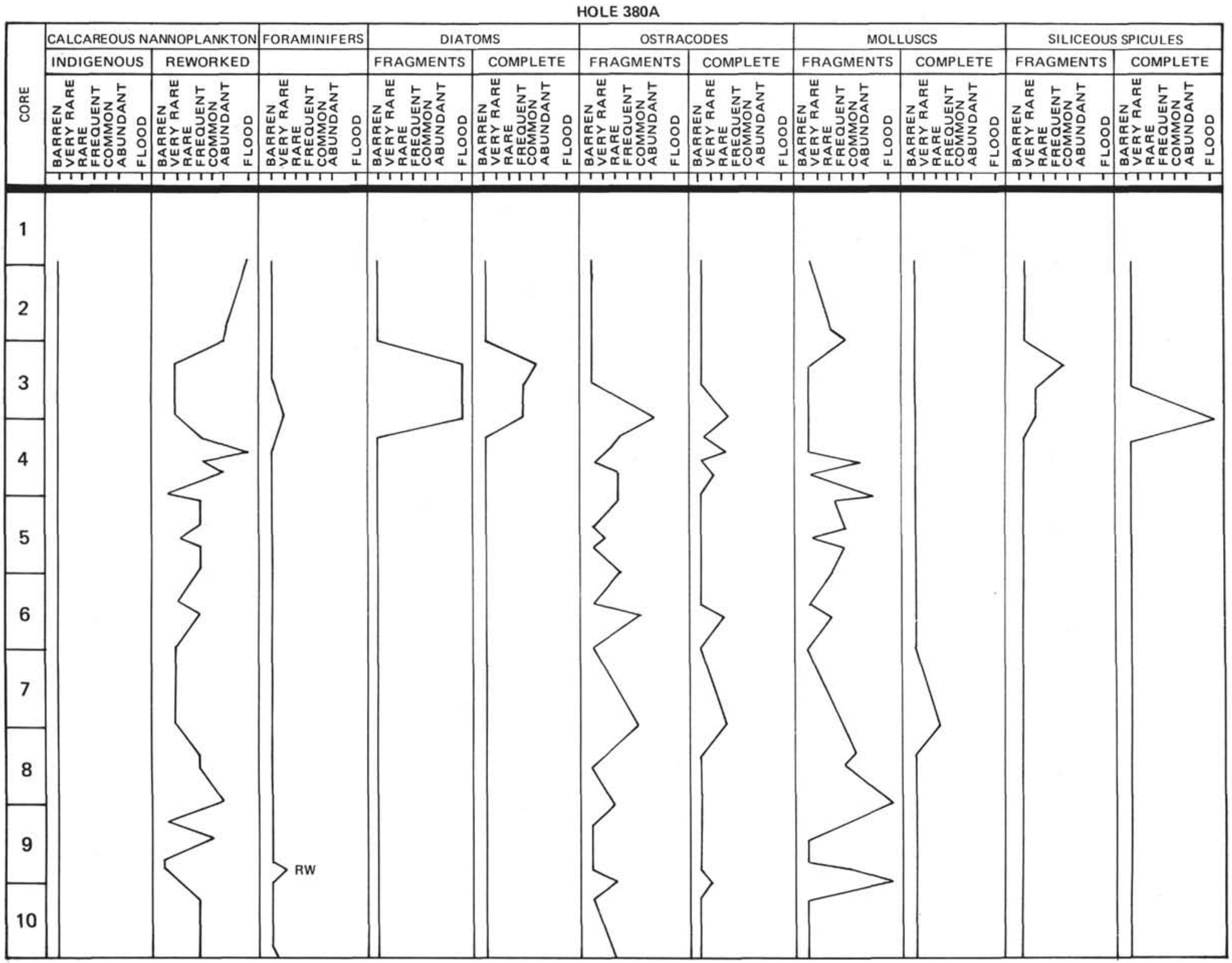
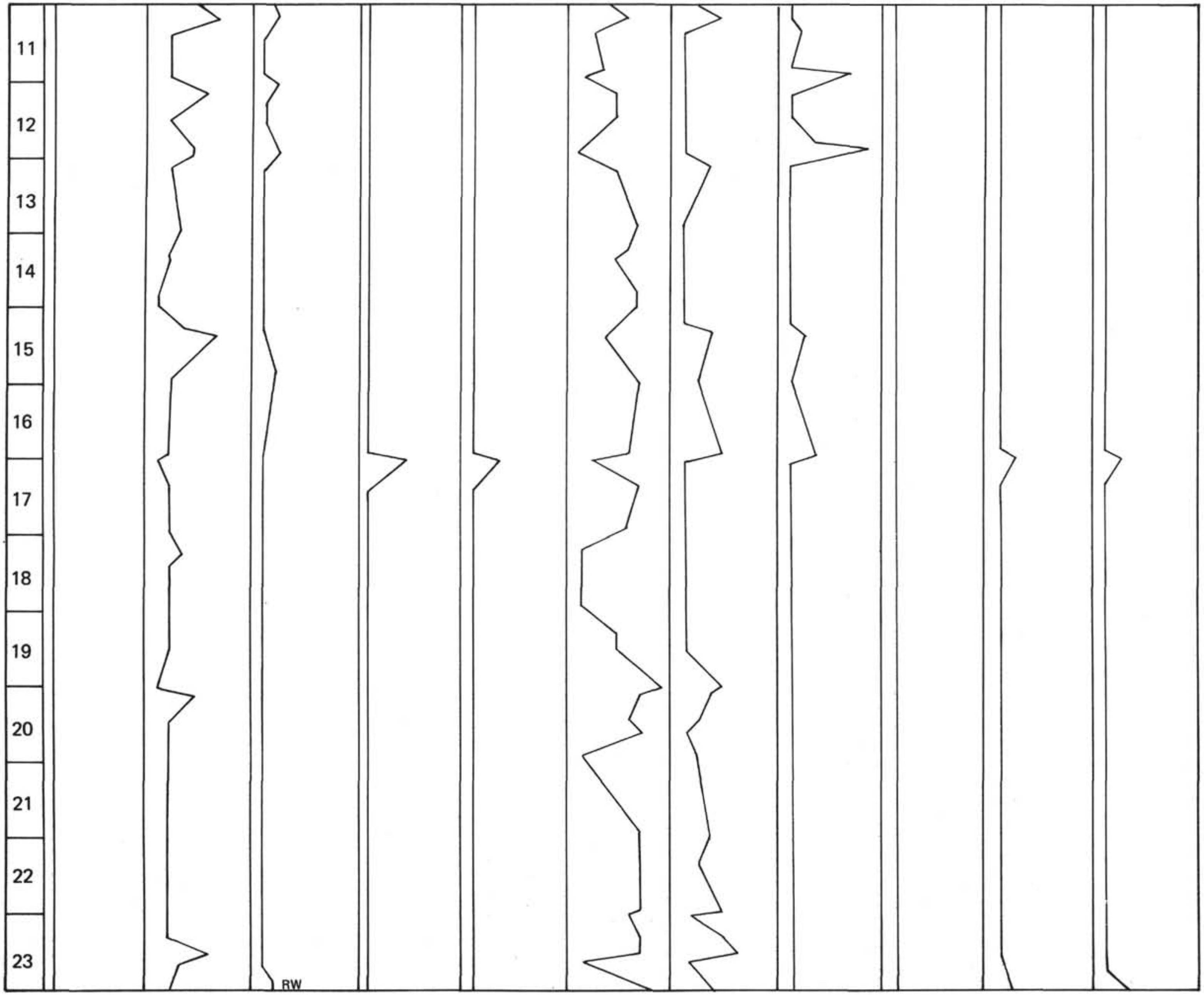
39
40

TABLE 3
Distribution of Various Fossil Groups in Hole 380A (RW=reworked)

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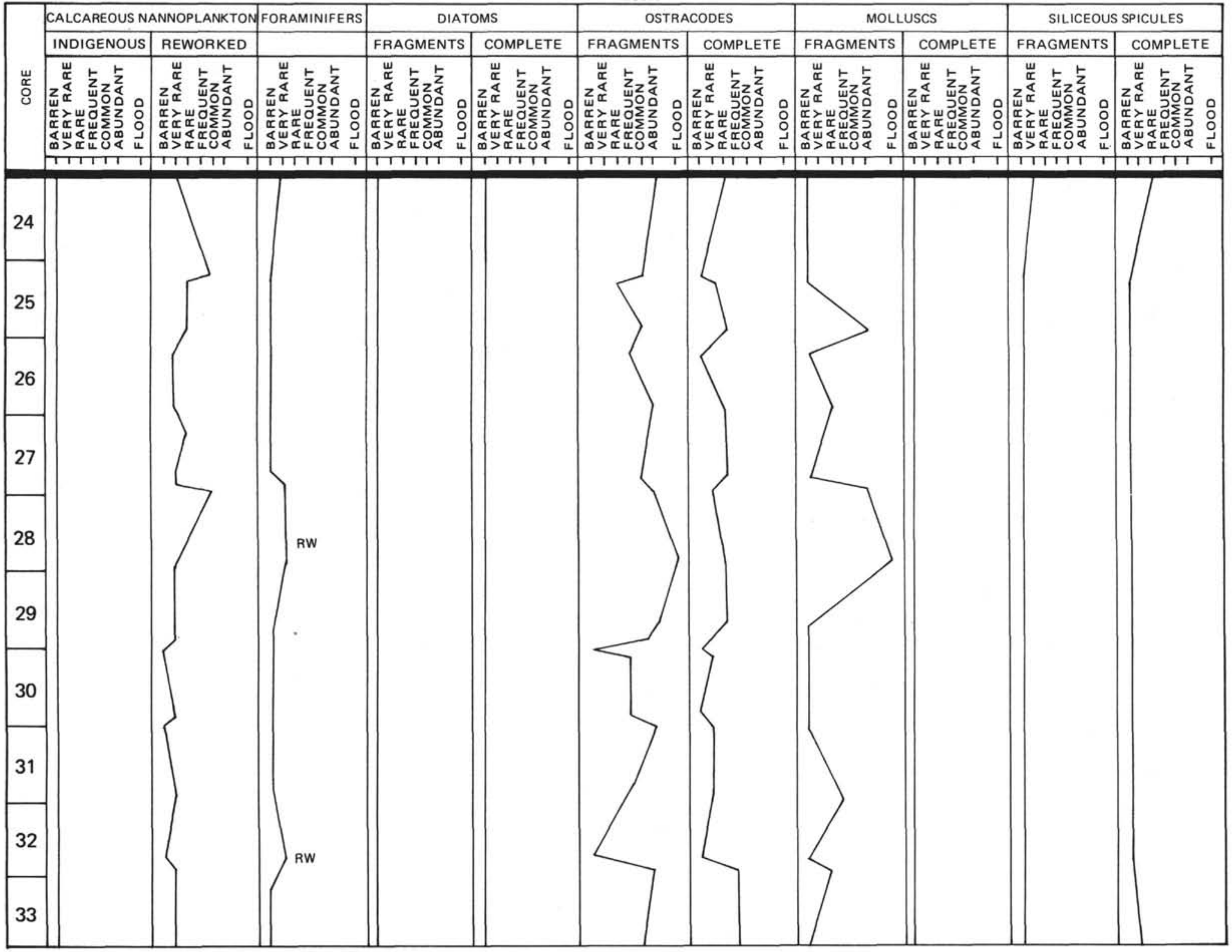
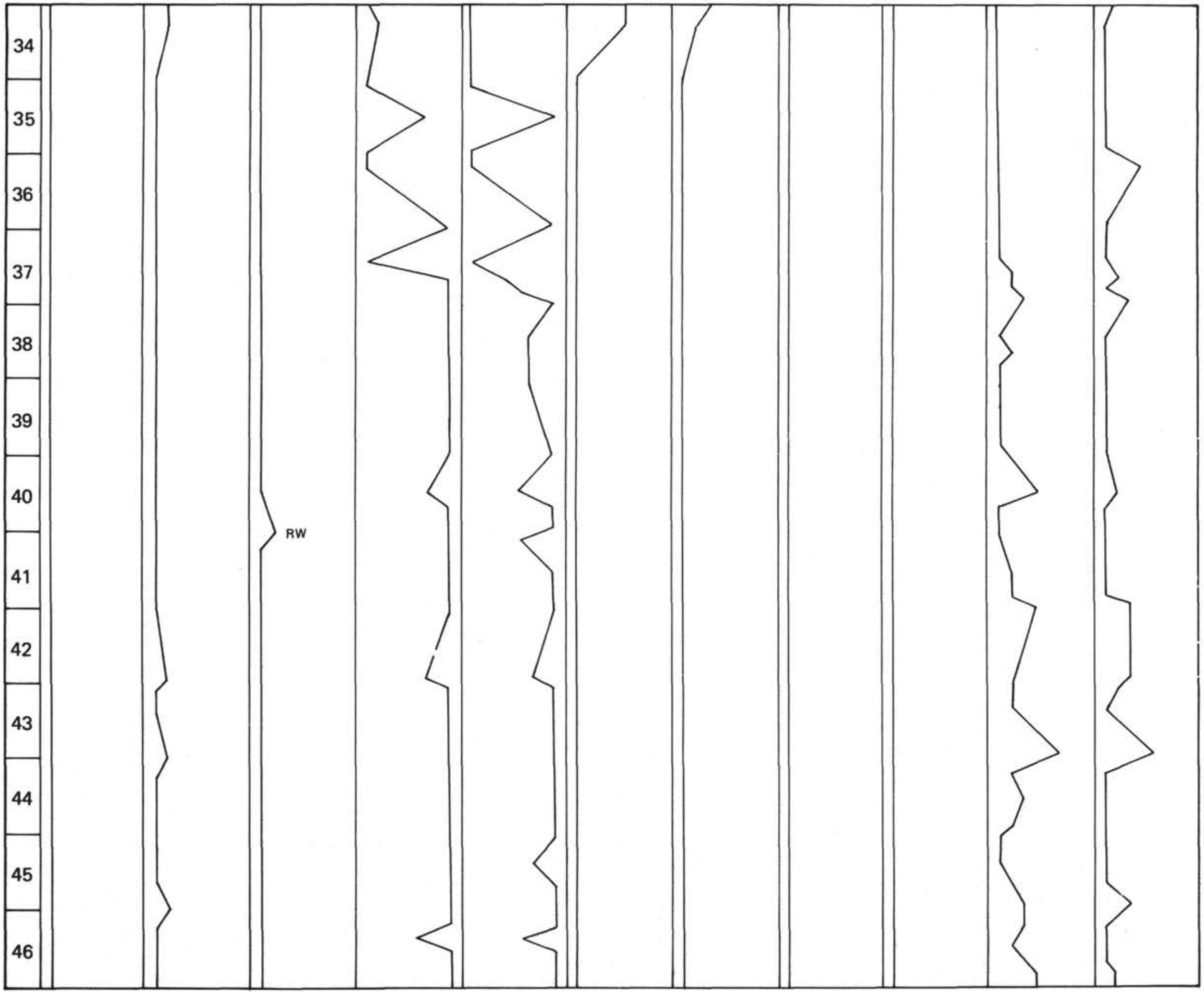
RW

TABLE 3 – *Continued*

HOLE 380A




34
35
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RW
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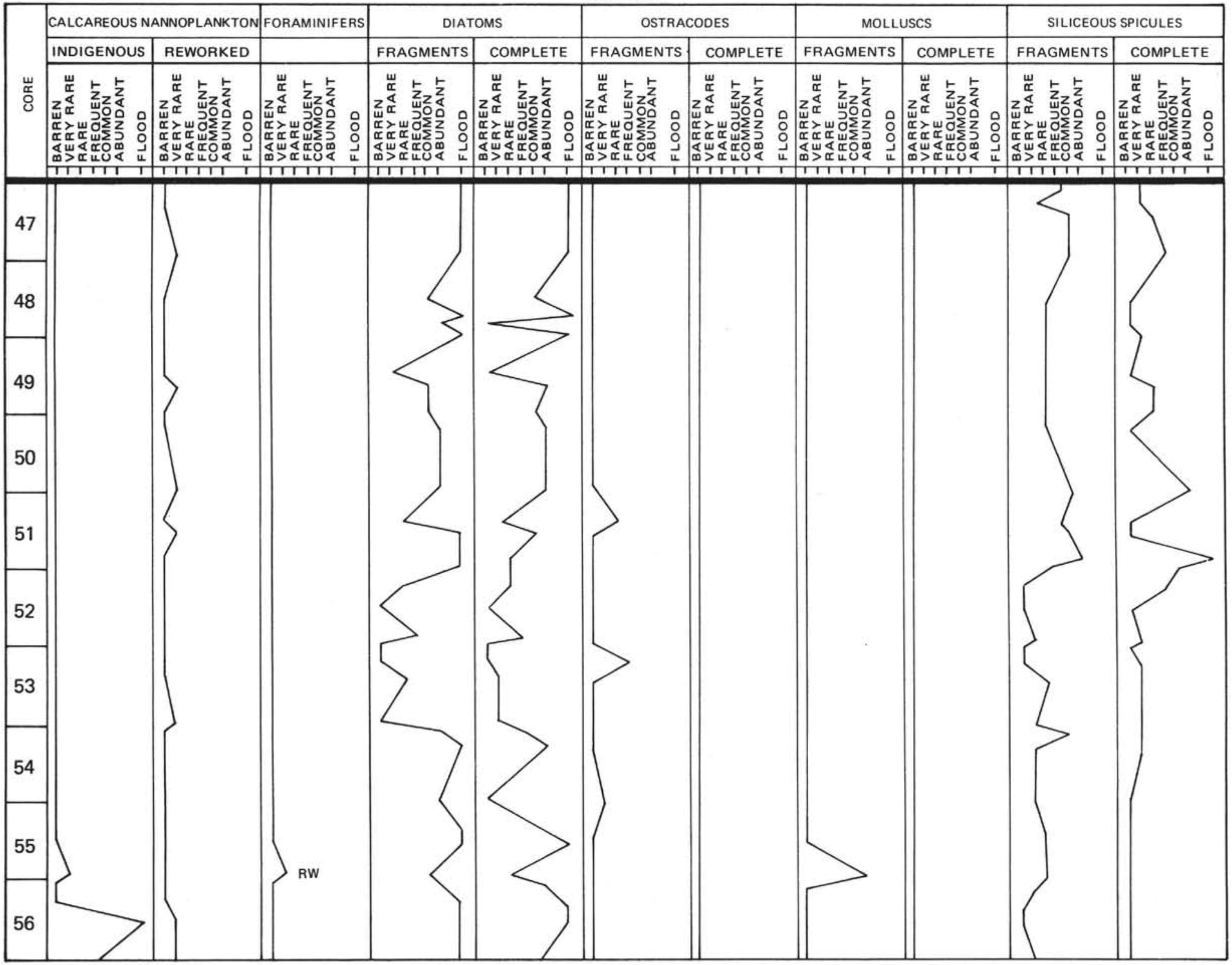
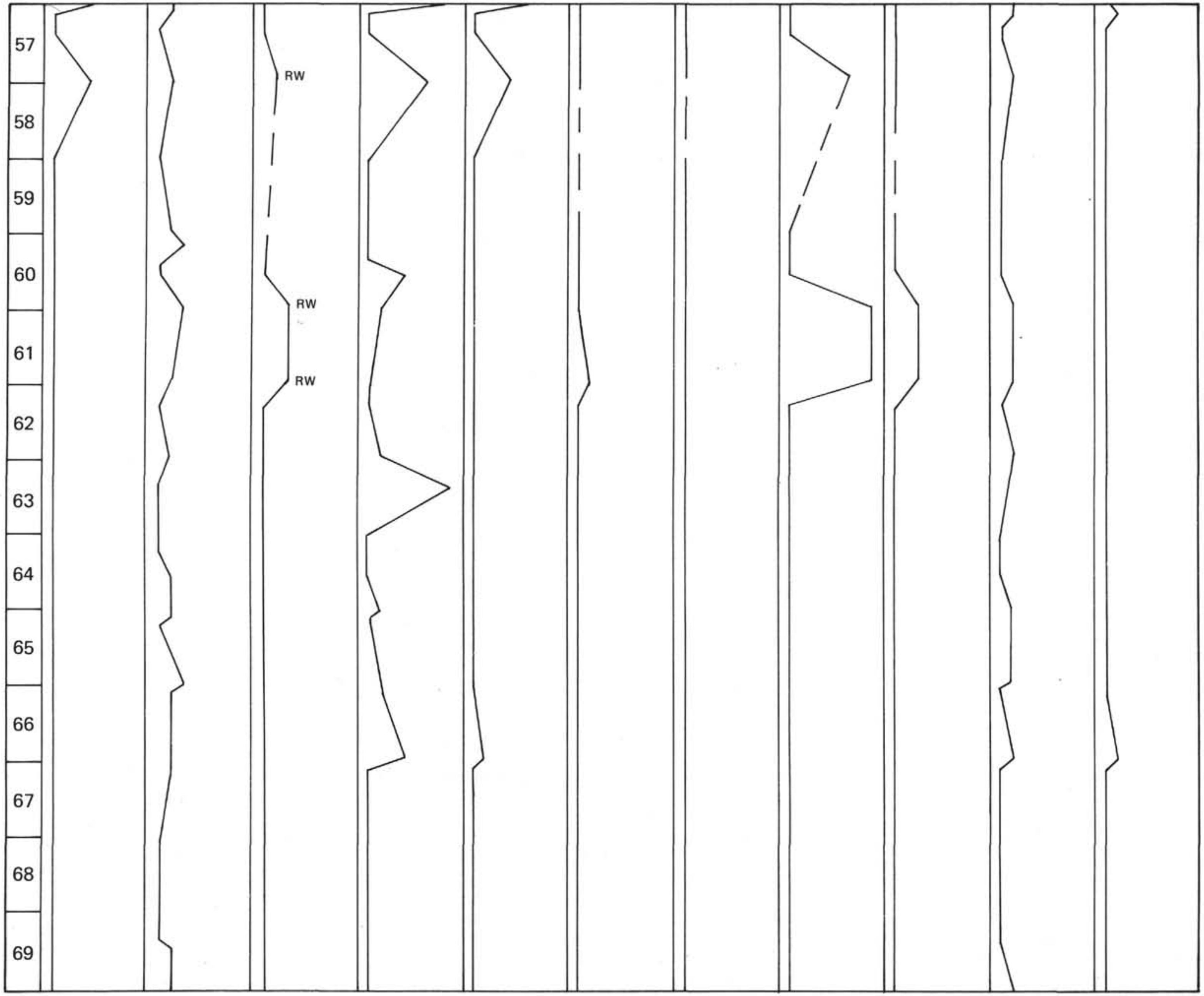
46

TABLE 3 – *Continued*

HOLE 380A




57
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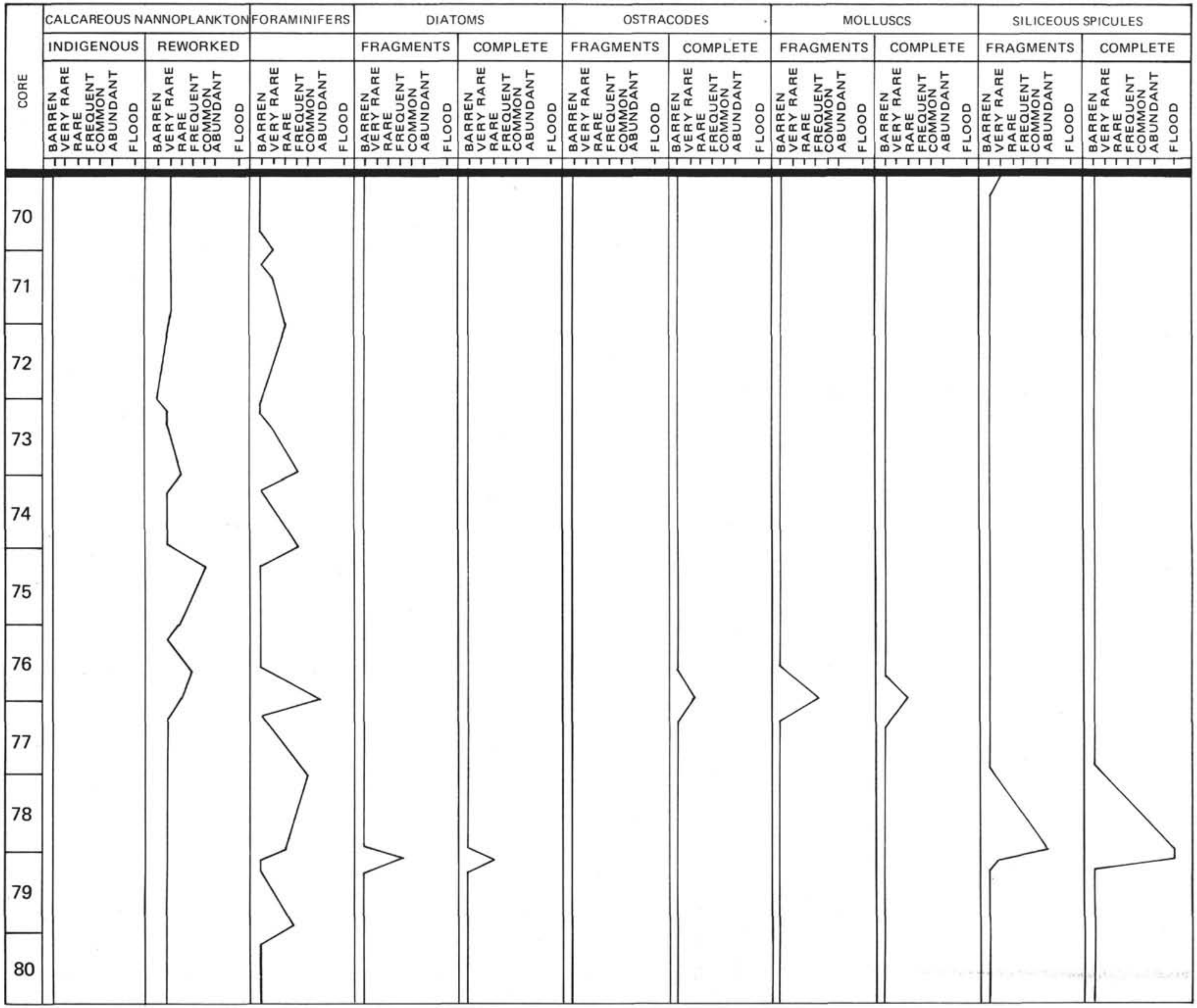
68
69
RW
RW
RW

TABLE 3 – *Continued*

HOLE 380A



Sea during a cold episode, though previous work had shown that the Black Sea was virtually fresh-water during the latter part of the last glaciation, and some have assumed this to be a cause-and-effect relationship. This would have led one to expect older cool periods to be represented by fresher water in the Black Sea, as contrasted with warmer intervals which would have been more or less marine because of higher strands of the oceans.

The long "Pre-Alpha" record penetrated at Hole 380-380A shows smaller SFI values below Core 33, Core 80 being almost 0 (see Figure 4). The MI also declines from Core 54 to Core 65, below which it is a little higher. Abundant palm pollen is encountered in Core 71, indicating probable early Pliocene age, and, it is probable though not certain, based on palynological analyses now available, the the bottom of Hole 380A (at least Cores 78-80), penetrated the upper Miocene.

GEOCHEMISTRY

Gas Analysis

Methane was present in most cores at Site 380. Only traces of ethane were present near the surface but there was a steady decrease in the mole ratio of CH_4/C_2H_6 with depth to about 5000 at 375 meters and 2000 at 600 meters. At the latter depth there was a decrease in ethane concentration after which the trend in ethane increase was resumed at about the same rate as in the upper section. Around 875 meters there was an increase in ethane concentration to a CH_4/C_2H_6 mole ratio of about 650 to 930 meters. From here to total depth there was no apparent change in the ethane concentration. An interesting result was obtained on a gas analysis from the pressure core barrel. Core 28 at a depth of about 590 meters was taken at about formation pressure. It contained gas with a CH_4/C_2H_6 mole ratio of about 18,000 compared to ratios of about 2000 on Cores 27 and 29 taken above and below the pressure core barrel sample. If this value is not an artifact, it indicates that there is considerable fractionation of the methane-ethane mixture as it forms the gas phase. Unfortunately, this difference could not be checked further because the pressure core barrel failed on subsequent tests.

Interstitial Salinity

In Site 380 the fresh water section noted in Site 379 was present but strongly attenuated. It reaches a low salinity level of 16.5‰ and does not extend below about 40 meters. After several breaks in slope a smooth increase in salinity to about 98‰ is obtained. This increase in salinity and in Ca and Mg confirms the previous evidence that a hypersaline stage existed in the Black Sea, but did not reach the point of depositing significant concentrations of solid evaporites.

The smoothness of the diffusion curve with depth for chloride indicates that diffusion has in fact been the dominant force controlling distribution of interstitial concentrations of Cl and salinity; i.e., there is no evidence of bulk fluid flow rapid enough to create sharp fluctuations in the trends.

Extremely high values (to 95 meq/kg) of alkalinity were suddenly obtained in the vicinity of 870 meters. The origin of these observations has not been clarified.

Other Aspects

A partial analysis of "sideritic-ankeritic" concretions revealed relatively small concentrations of magnesium or calcium, but chiefly iron and lesser manganese. The hard lumps associated with organic-rich and partly woody sediments may therefore prove to be manganosiderite. Analyzed samples contained about 17% insoluble residue.

Formation factors obtained from resistivity measurements revealed an increase from the sea floor to about 320 meters and thereafter relatively constant fluctuations to nearly 900 meters. A similar constancy was observed in water content. The diatomaceous marls appear to be the most permeable rocks obtained in the lower section, whereas sand beds intercalated with gray clays and shales are prominent in the upper section. Cemented limestones beginning at 870 meters reach formation factors of several hundred, corresponding to dense lithified rocks.

PHYSICAL PROPERTIES

Density, Water Content, Sound Velocity, and Thermal Conductivity

Wet bulk density values at Site 380 increase downwards from very low values of about 1.5 g/cc near the mudline to between 1.9 and 2.0 g/cc at about 600 meters subbottom. Density remains approximately constant in the slumped calcareous oozes recovered from between 488 and 646 meters subbottom, and then declines dramatically to about 1.6 g/cc near the top of the underlying marls and laminated clays and carbonates. Although the density values between 730 and 1050 meters are highly variable, a gradual downward increase in density is evident (Figure 26).

Water content data are also highly variable, and tend to be negatively correlated with the wet bulk density data (compare Figures 26 and 27). Specifically, water content is high, up to 50 weight percent, near the mudline, and decreases rapidly and smoothly with depth in the muds and sandy silts to about 22 weight percent at 300 meters subbottom. A small, but clearly defined increase in water content to about 25 weight percent occurs near the top of the underlying marls, muds, and oozes, followed once again by a downward decrease to values of about 22 weight percent at the top of the calcareous ooze unit, in which the water content appears to remain fairly constant. At the base of the calcareous ooze layer another abrupt increase in water content occurs, followed once again by a decrease to about 20 weight percent near the bottom of the hole at about 1500 meters (Figure 27).

Sound velocity measurements were generally not possible in the sediments recovered from above about 700 meters due to their high content of interstitial gas. Where data were obtained, rapid attenuation of the acoustic signal in the sediment made accurate velocity determinations difficult. The scarcity of the data from above 724 meters precludes any conclusion other than that the sediments are generally gassey, and the few measurements that were made indicate highly variable velocities (1.47 to 3.69 km/sec).

Sound velocities were successfully measured between 724 and 1066 meters subbottom. These data are easily divided into two groups (Figure 28). One set of velocity data, measured over this entire interval, fell in the range from about 1.75 to 2.1 km/sec. A second set of data obtained in the lowermost 200 meters of the hole had velocities between 2.9 and 5.9 km/sec. The first set of lower and less variable velocity data exhibits a tendency to increase slowly with depth down to the top of the region below which much higher and more variable velocities were measured in coarse clastics and interbedded laminated marls, varved carbonates, structureless marls, and thin dolomite layers. The high veolcities and variability in this region are a consequence of the complex lithology and the presence of carbonate and carbonate-cemented layers which characteristically have high seismic velocities.

Thermal conductivity data were obtained from near the sea floor to almost 500 meters subbottom. These data are highly variable and range from 2.03 to 3.70 mcal/cm sec°C, with a mean of 2.69 ± 0.40 mcal/cm sec°C. The high variability obscures, but does not completely hide, a general downward increase in thermal conductivity with depth (Figure 29). Part of the cause of the high variability is probably due to anomalously low conductivity values caused by the presence of varying amounts of interstitial gasses either in the form of small, uniformly disseminated bubbles or as larger, gas-filled (and caused) voids. In addition, structural disturbances due to different mechanical properties of the highly variable lithologies present at this site often produced a core consisting of fragments of high thermal conductivity, consolidated sediments in a matrix of softer muds. The proportion, type, size, and proximity of these fragments to the thermal conductivity measurements can have a major effect on the measured conductivity.

All the data discussed above are presented in Tables 1 through 4 of the Appendix.

Heat Flow

Downhole temperatures were measured at eight depths in Holes 380 and 380A, giving five highly reliable sediment temperatures and three values which are not believed to be representative of in situ sediment temperatures. The five reliable temperatures between 104.5 and 370.5 meters subbottom define a nearly constant geothermal gradient of 35°C/km, nearly equal to the average gradient of 36°C'km determined at Site 379. Five interval heat flow values were calculated from the downhole temperature data, bottom water

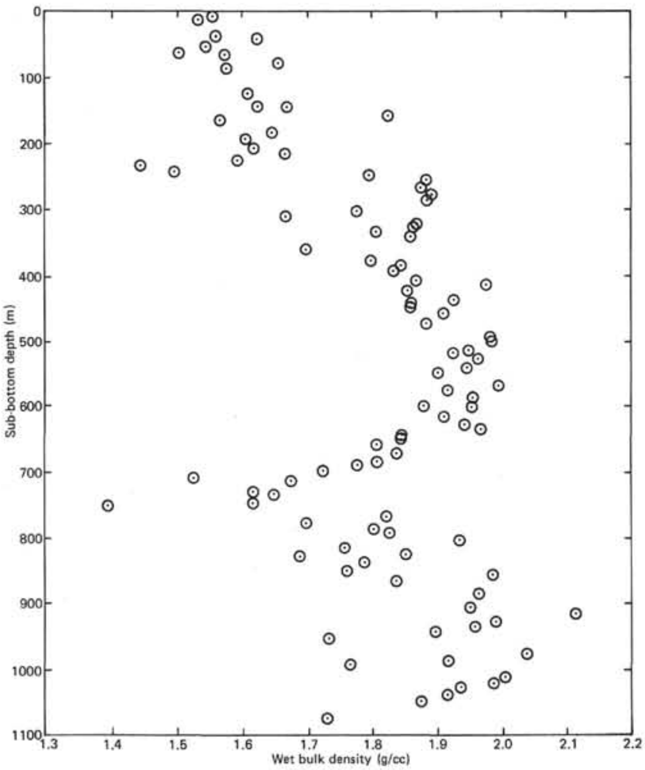


Figure 26. *Plot of wet bulk density versus subbottom depth at Site 380. Wet bulk density data were obtained using the gamma ray attenuation techniques.*

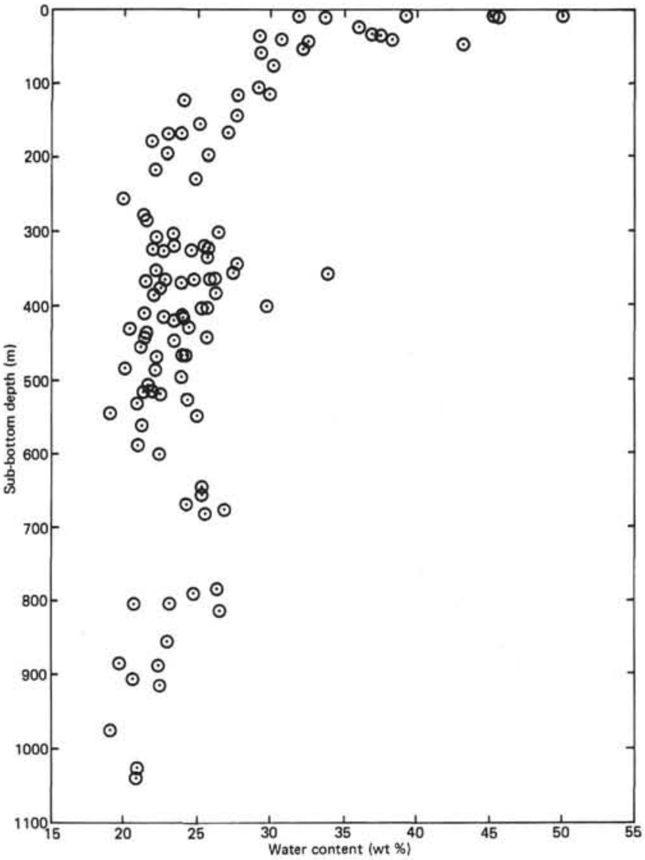


Figure 27. *Plot of water content versus subbottom depth at Site 380. Water content data were calculated by weighing sediment samples obtained by the syringe technique before and after drying.*

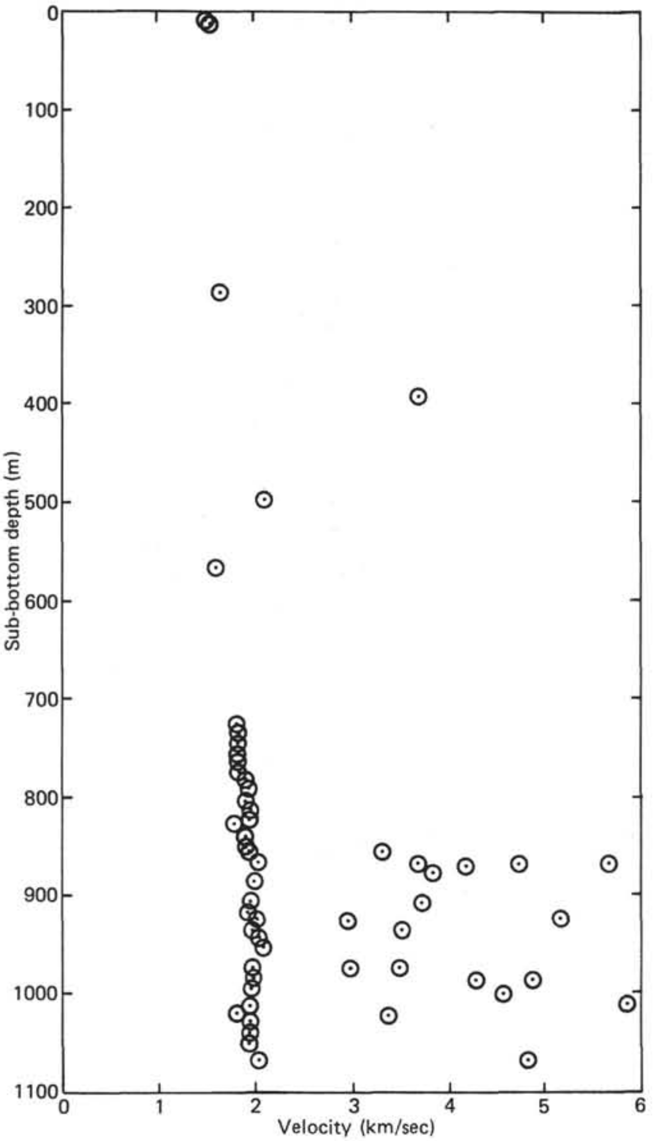


Figure 28. *Plot of compressional wave velocity data versus subbottom depth at Site 380.*

temperature determined as the temperature probe passed through the drill pipe, and shipboard thermal conductivity measurements. The mean and standard deviation of the interval heat flow values is 0.99 ±0.10 × 10^{-6} cal/cm²sec. This value is in good agreement with the heat flow value determined at Site 379 (0.98±0.15 × 10^{-6} cal/cm²sec) and with nearby conventional oceanographic heat flow measurements. An anomalously high downhole temperature was recorded at 152.5 meters subbottom. This measurement is anomalous both with respect to its relationship to the other downhole temperatures and because it is higher than temperatures recorded below it. The possible significance of this observation, as well as additional discussion on the quality and interpretation of the other temperature data, can be found in the report by Erickson elsewhere in this volume.

CORRELATION OF REFLECTION PROFILES, PHYSICAL PROPERTIES, AND LITHOLOGIES

The general area for Site 380 was determined on the basis of seismic profile 21 of the 1969 cruise of *Atlantis* II-49 (Ross, et al., 1974, p. 20, figure 14). Unfortunately there are no deep seismic lines correlating the main reflectors of this profile with any from the center of the western portion of the Black Sea. However, one may assume that the deep reflectors shoal towards Site 380, and this possible correlation of the main reflectors is shown in Figure 30. A similar sequence of reflectors (A, B, C, and D) were detected from both sites and during the approach and departure from Site 380 (Figure 31). The depths to these reflectors were calculated by using measured velocities in cores (Physical Properties Section, Table 4 and Figure 32).

A comparison of the seismic layers with the lithology (right part of Figure 32) shows that reflectors A, B, C, and D correlate well with lithologic changes. Thus reflector A may correspond to the top of turbidites at a depth of about 360 meters. Reflector B corresponds to the boundary between lithological Units I and II. Reflector C corresponds to the boundary between Units II and III. Reflector D corresponds to the top of the sediments which have a lot of hard rocks intercalated.

Reflectors A, B, and D also correlate well with sudden increases of wet bulk density.

SUMMARY AND CONCLUSION

Two holes were drilled and essentially continuously cored and five major sedimentological units (with some subunits) were distinguished: (1) muds, sandy silts (from 0-332.5 m depth); (2) marls, muds, varves, dolomite, dolomitic marls, and calcareous ooze ("Seekreide") (from 332.5-448 m); (3) calcareous oozes ("Seekreide"), marls (448-646 m); (4) marls, laminated clays, laminated carbonates with siderite and dolomitic intercalations (646-969 m); (5) black shales (969-1074 m).

Spores and pollen were most useful at this site allowing a zonation into steppe (glacial) and forest (interglacial) vegetation. This allowed a subdivision of the Quaternary record into three colder drier intervals (alpha, beta, gamma) and four warmer periods (pre-Alpha, Anna, Betty, Celia). There may also be a correlation in diatoms with this zonation. In addition this subdivision was useful in correlating between Sites 379 and 381. One interesting and important point is that only three major glacial or cold episodes were noted. The lowermost core examined had late Pliocene pollen and spores. Most of the cores (60%) studied were non-marine.

Indigenous calcareous nannoplankton are relatively rare although reworked forms are common. Planktonic foraminifers were not present and benthic forms were rare. Ostracodes, diatoms, otoliths, siliceous spicules, and molluscs occur at discrete intervals.

A tentative classification of sediment units with glacial and interglacial stage can be made:

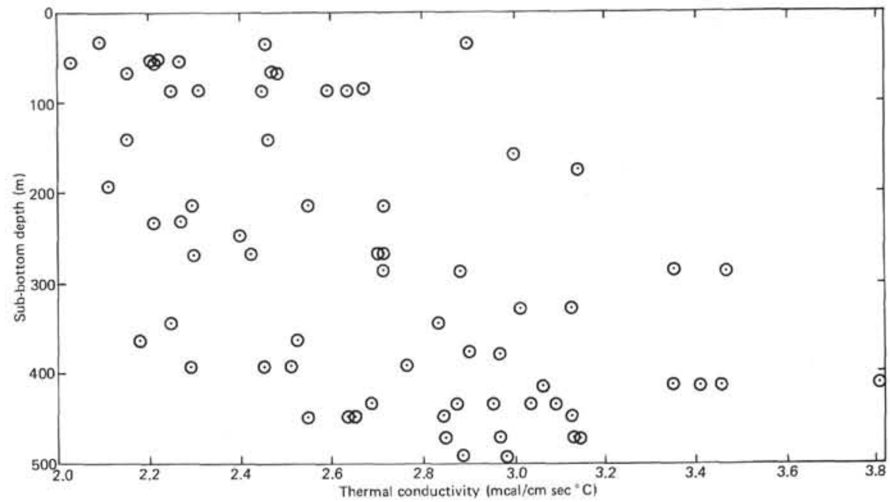


Figure 29. *Plot of compressional wave velocity data versus subbottom depth at Site 380.*

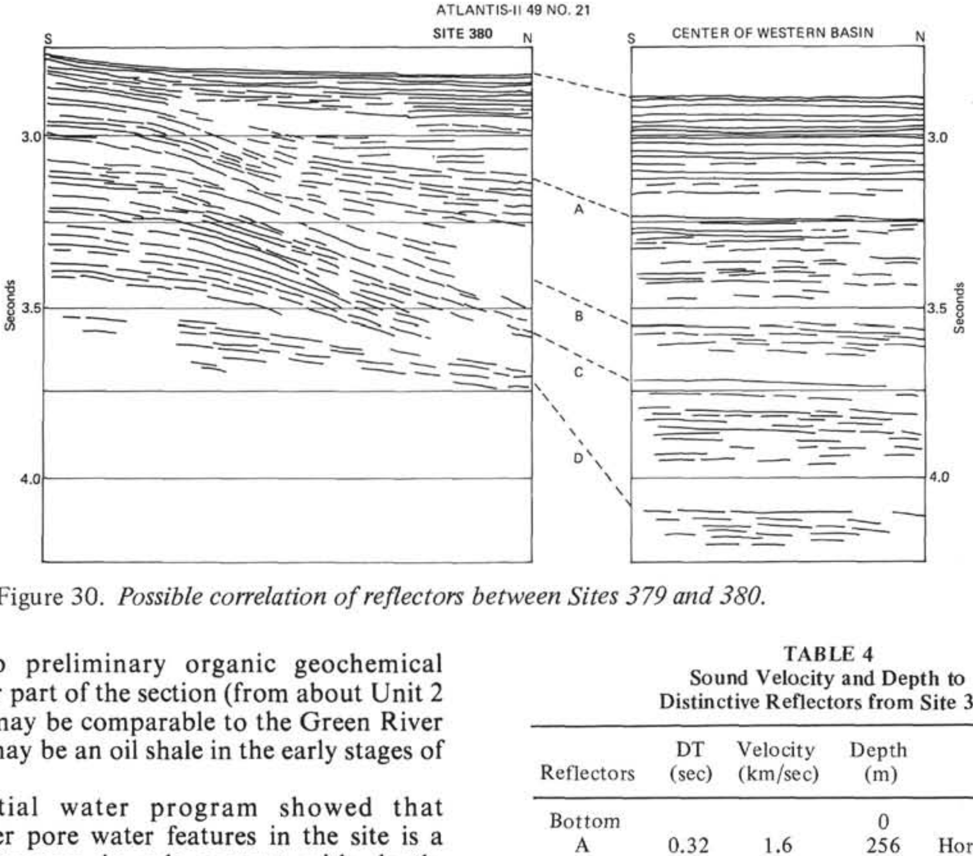


Figure 30. *Possible correlation of reflectors between Sites 379 and 380.*

TABLE 4
Sound Velocity and Depth to
Distinctive Reflectors from Site 380

Reflectors	DT (sec)	Velocity (km/sec)	Depth (m)	Remarks
Bottom			0	
A	0.32	1.6	256	Horizontal layering
B	0.43	1.6	344	Gentle slope
C	0.51	1.8	459	Increasing slope
D	0.93	1.9	875	Increasing slope

According to preliminary organic geochemical studies the lower part of the section (from about Unit 2 to total depth) may be comparable to the Green River formation and may be an oil shale in the early stages of formation.

The interstitial water program showed that dominating other pore water features in the site is a slow, smooth increase in salt content with depth, reaching a maximum of about 98$^0/_{00}$ salinity in the deepest investigated strata. This indicates a brine or evaporite source well below the penetrated strata, and appears to require considerable time to allow diffusion to smooth the curves. The smoothness is also in strong contrast to much more marked "paleosalinity" features in Site 379.

Diffusimetry studies showed that as a whole, the site permitted significant diffusion of salts and gases through interconnected pore fluids, even though very hard, cemented carbonates with high formation factors (to 500) (low diffusive permeability) were encountered below 880 meters. These may be discontinuous. A thick section, in the center of the site shows constant formation factors and water content, and may reflect slumped or otherwise disturbed structures. Heat flow was 0.99 ±0.10 × 10^{-6} cal/cm^2 sec, a value similar to Site 379.

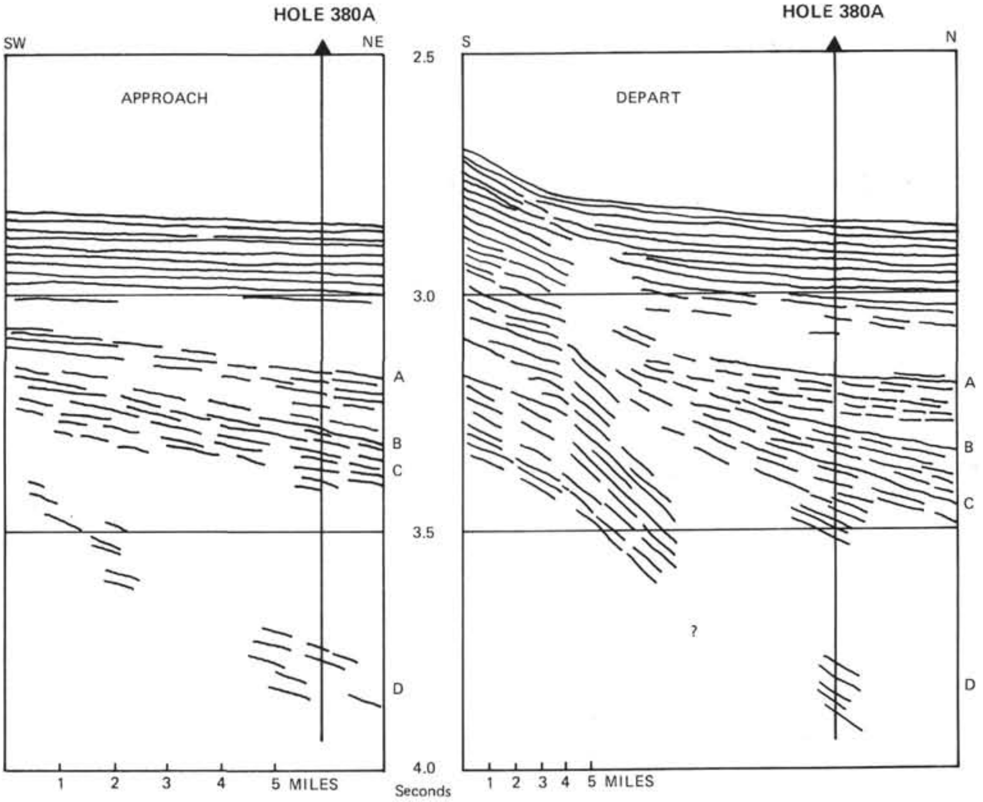


Figure 31. *Similarities of layers between approach to and departure from Site 380.*

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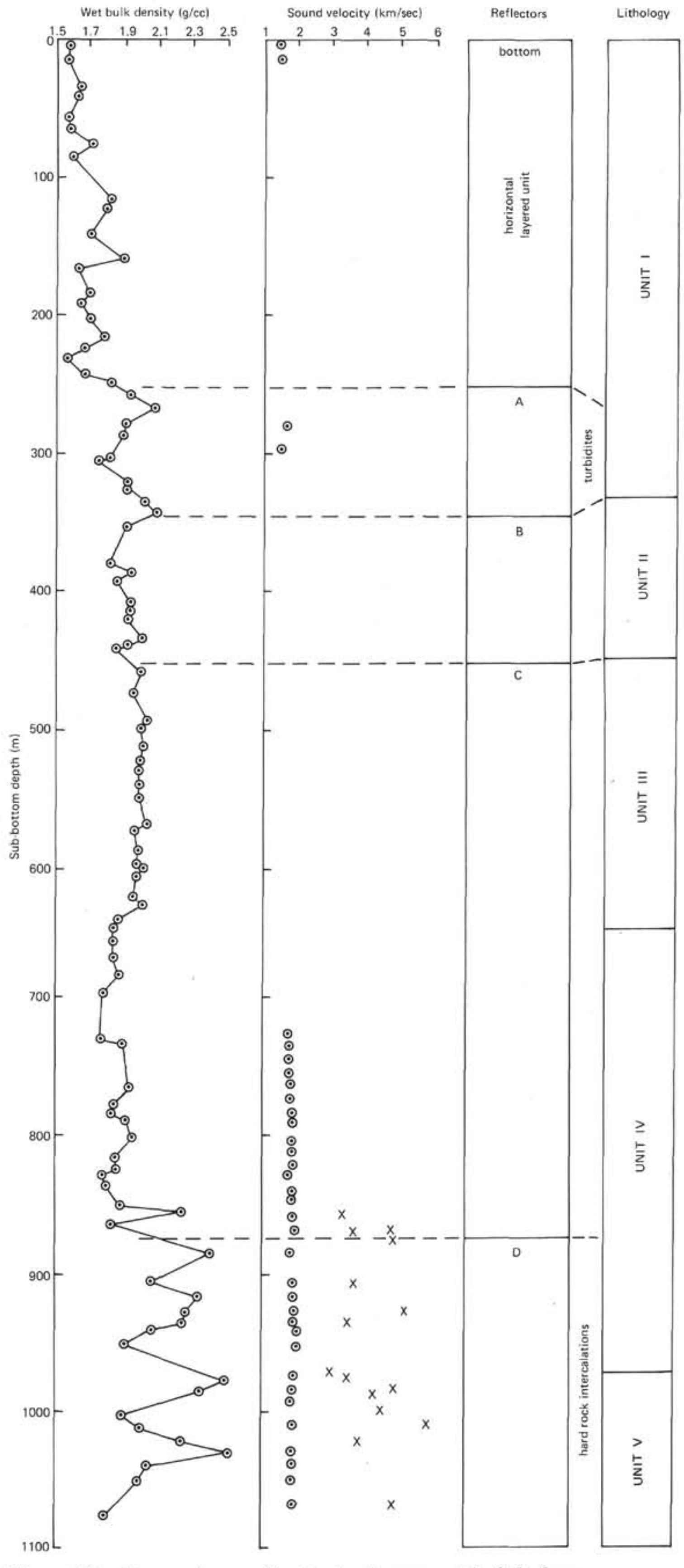
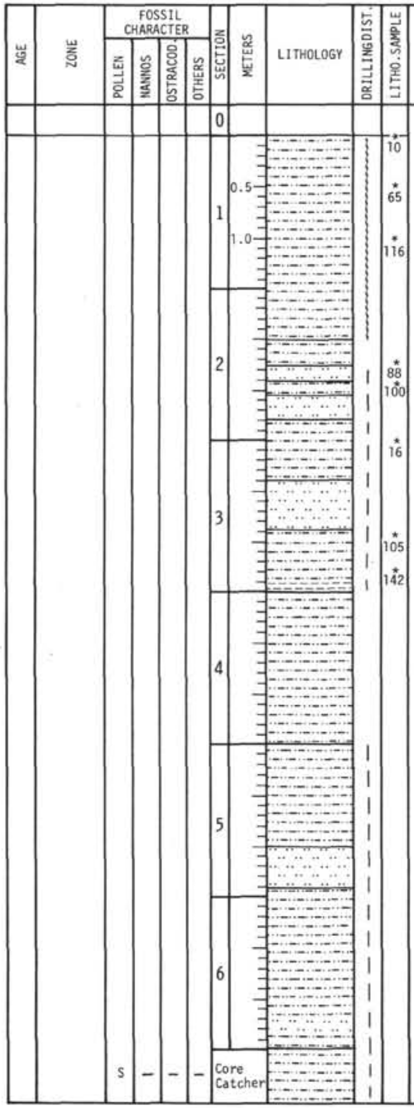


Figure 32. *Comparison of seismic layers with lithology, Site 380.*

Site 380 Hole Core 1 Cored Interval: 0.0-9.5 m



LITHOLOGIC DESCRIPTION

BLACK MUD, CALCAREOUS MUD AND SANDY SILT

Black mud on top 2 m. The bottom 7 m consists mainly of greenish gray (5GY 6/1) calcareous mud, with dark greenish gray (5GY 4/1) sandy silt interbeds, and a few intercalations of light brown (5YR 6/4) carbonate-rich mud and clay.

NO

DOMINANT LITHOLOGY (Black mud):
SS 1-65 cm
50% Detrital grains
20% Clay
10% Organic matter
5% Carb. unspec.
15% Diatoms

DOMINANT LITHOLOGY (Calcareous mud):
SS 2-100 cm
15% Detrital grains
40% Clay
5% Opaque
40% Carb. unspec.

5GY 4/1

5GY 6/1

MINOR LITHOLOGY (Sandy silt):
SS 2-85 cm
75% Detrital Quartz and Feldspar
5% Mica
5% Heavy minerals
5% Clay
5% Carb. unspec.

5YR 6/4

5GY 6/1

5YR 6/4

X-ray:

	Sec. 1		Sec. 2	
	72-74	104-106	50-51	138-140
Calcite	11%	12%	15%	13%
Dolomite	6%	5%	8%	4%
Quartz	33%	40%	19%	20%
Feldspar	7%	20%	6%	6%
Layered silicates	43%	33%	52%	57%
Carb. bomb	17%	17%	24%	17%

5GY 6/1

	Sec. 3	Sec. 6
	101-103	43-45
Calcite	9%	8%
Dolomite	3%	1%
Quartz	17%	16%
Feldspar	5%	6%
Layered silicates	66%	69%
Carb. bomb	12%	9%

5GY 4/1

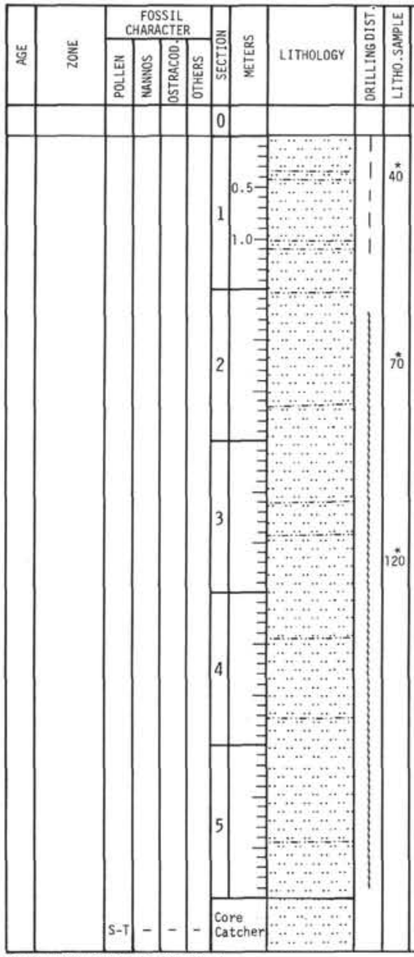
Grain Size:

	Sec. 1		Sec. 2	Sec. 3	Sec. 6
	72-74	104-106	138-140	101-103	43-45
Sand	12%	4%	0%	1%	0%
Silt	76%	75%	52%	46%	26%
Clay	12%	21%	48%	53%	74%

Carbonate:

	$CaCO_3$	Corg.
1-60 to 68	21%	0.6%
3-10 to 20	17%	0.9%
5-10 to 20	11%	0.6%
6-71 to 81	24%	0.5%

Site 380 Hole Core 2 Cored Interval: 9.5-19.0 m



LITHOLOGIC DESCRIPTION

SANDY SILT AND MUD

Dark greenish gray (5G 4/1) sandy silt with molluscan hash mixed with greenish gray (5G 6/1) mud.

Core was badly disturbed, especially Sections 3, 4, and 5.

DOMINANT LITHOLOGY (Sandy silt):
SS 1-40 cm
40% Quartz and Feldspar
20% Clay
10% Carb. unspec.
28% Mollusc fragments
2% Heavy minerals

DOMINANT LITHOLOGY (Mud):
SS 3-120 cm
60% Detrital terrigenous grains
40% Clay
Tr Carbonate

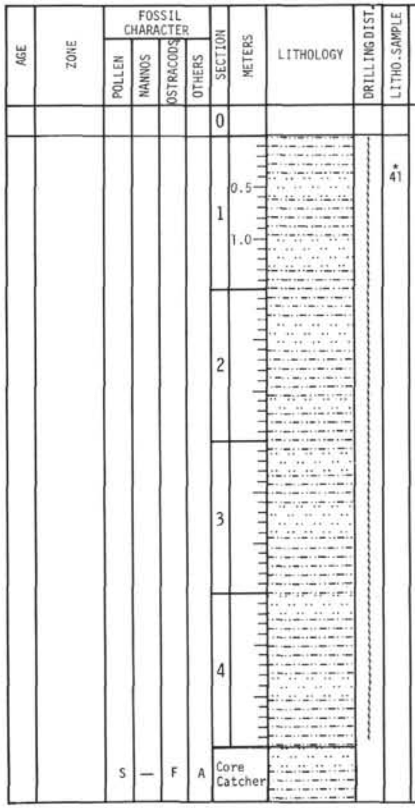
Carbonate:

	$CaCO_3$	Corg.
1-62 to 67	41%	0.2%
2-40 to 52	22%	0.2%
3-57 to 70	21%	0.4%

Site 380, Core 3, 19.0-27.5 m NO RECOVERY

Explanatory notes in Chapter 1

Site 380 Hole Core 4 Cored Interval: 27.5-38.0 m



LITHOLOGIC DESCRIPTION

MUD, SANDY SILT AND SAPROPELIC MUD

Core very badly disturbed.
Mixture of:
1) greenish gray (5G 6/1) and medium bluish gray (5B 5/1) muds;
2) gray black (N2) sapropel and dark gray (N4) sapropelic mud; and
3) dark greenish gray sandy silt with small shells.

Mud is the dominant lithology, 1 bleb of sapropel at Sec. 1, 40 to 43 cm. Several small pockets of sandy silt.

DOMINANT LITHOLOGY (Mud):
SS 2-116 cm
15% Quartz and Feldspar
80% Clay
5% Carb. unspec.

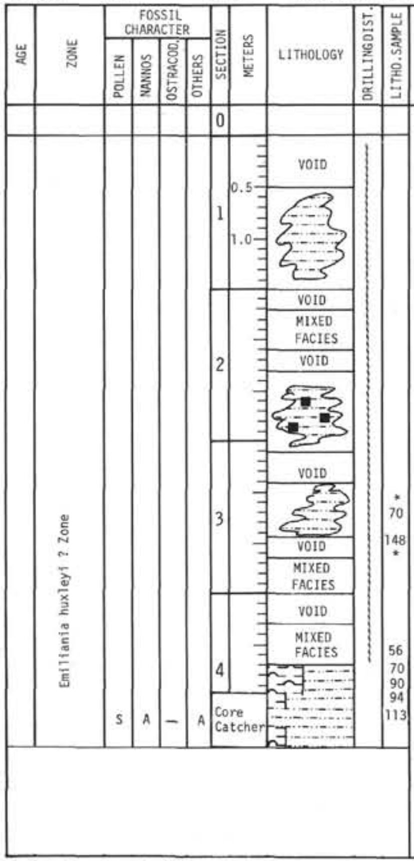
MINOR LITHOLOGY (Sapropel):
SS 1-42 cm
30% Quartz and Feldspar
50% Clay
20% Organic matter
Tr Carb.

MINOR LITHOLOGY (Silty sand):
65% Quartz and Feldspar
5% Mica
5% Heavy minerals
5% Clay
3% Opaque
5% Shell fragments
15% Carb. unspec.

Carbonate:

	$CaCO_3$	Corg.
1-19 to 28	9%	0.4%
3-18 to 31	4%	1.0%
4-120 to 133	18%	0.6%

Site 380 Hole Core 5 Cored Interval: 38.0-47.5 m



LITHOLOGIC DESCRIPTION

Sections 1 to top of 4, badly injected: Section of 3 major facies: shown schematically:
1) dark greenish gray (5G 4/1) SANDY SILT and SILTY SAND;
2) BLACK MUD, dark gray (N3); and
3) MUD, greenish gray (5G 6/1).

SS 70 cm
[0, 20, 80]
20% Quartz and Feldspar
1% Heavies
1% Opaque
TR Detrital carb.
80% Clay

Diatoms appear, 15% in SS 148 cm Sec 3; 56 cm, Sec. 4.

DIATOMACEOUS MUD, olive colors as shown:
DOMINANT WITH:
10-30% Quartz and Feldspar
~30-40% Clay
10-25% Diatoms

SS 113 cm - only trace diatoms, 50 diatoms are variable.

X-ray:

	Sec. 3 146-148	Sec. 4 57-59	71-73
Calcite	5%	6%	3%
Dolomite	3%	4%	2%
Quartz	19%	25%	17%
Feldspar	7%	9%	6%
Layered silicates	66%	56%	72%
Carb. bomb	8%	10%	5%

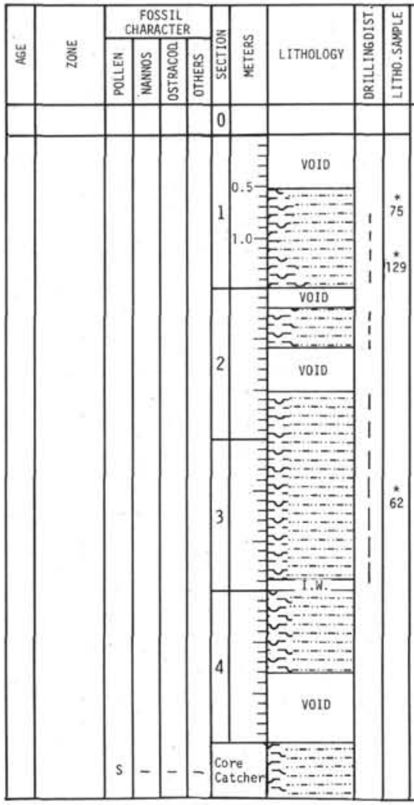
Grain Size:	Sec. 3 146-148	Sec. 4 57-59	71-73
Sand	8%	14%	7%
Silt	63%	51%	49%
Clay	29%	35%	44%

Carbonate:

	$CaCO_3$	Corg.
1-82 to 95	11%	0.6%

Explanatory notes in Chapter 1

Site 380 Hole Core 6 Cored Interval: 47.5-57.0 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS MUDS in various shades of olive gray, mainly 5Y 4/2, mixed by drilling with stringers of sandy silts which are devoid of diatoms.

Sec. 4 below 80 cm:
Muds are:
1) light olive gray (5G 5/2), finer, greener and richer in diatoms (SS 4-77 cm), and
2) greenish gray (5G 5/1), coarser grayer, and poor in diatoms (SS 4-88 cm), some sandy silt layers (SS 4-135 cm).

DOMINANT LITHOLOGY (Diatom mud):
SS 4-88 cm
25% Quartz and Feldspar
50% Clay
5% Opaques
10% Carb.
10% Diatoms
Tr Nannos

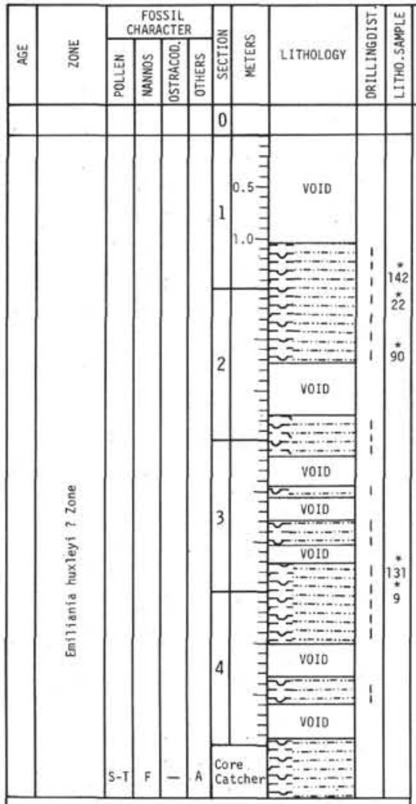
MINOR LITHOLOGY (Diatom marl):
SS 4-77 cm
10% Quartz and Feldspar
35% Clay
10% Pyrite
20% Carb.
25% Diatoms

MINOR LITHOLOGY (Sandy marl):
SS 4-139 cm
25% Quartz and Feldspar
>5% Pyrite and Heavy minerals
10% Clay
50% Carb.
15% Diatoms

<u>Carbonate</u>:

	$CaCO_3$	Corg.
1-93 to 105	13%	1.4%
4-12 to 33	13%	1.1%

Site 380 Hole Core 7 Cored Interval: 57.0-66.5 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS MUD with intercalcations of *DIATOMACEOUS MICRITE and SANDY* SILTS.

Olive gray diatom-rich muds (like Core 6) with numerous thin laminae of dusky yellow (5Y 6/4) diatomaceous marls, plus a few sandy silt and mud layers.

The diatomaceous micrite may consist of a mixture of <u>Braarudosphaera pentlets</u> *and diatom and may be equivalent to* the nannofossil marl of Site 379, Core 11.

DOMINANT LITHOLOGY (Diatom mud):
SS 2-70 cm
20% Quartz and Feldspar
50% Clay
10% Opaque
10% Carb.
10% Diatom

MINOR LITHOLOGY (Diatom marl):
SS 1-142 cm
5% Quartz and Feldspar
10% Clay
60% Carb.
25% Diatom

MINOR LITHOLOGY (Mud):
SS 2-22 cm
35% Quartz and Feldspar
5% Mica
5% Heavy minerals
38% Clay
10% Opaque
15% Carb.

<u>X-ray</u>:

	2-22 to 23	4-17 to 18
Calcite	2%	8%
Dolomite	7%	2%
Quartz	39%	15%
Feldspar	29%	9%
Layered silicates	23%	66%
Carb. bomb	9%	10%

<u>Grain Size</u>:

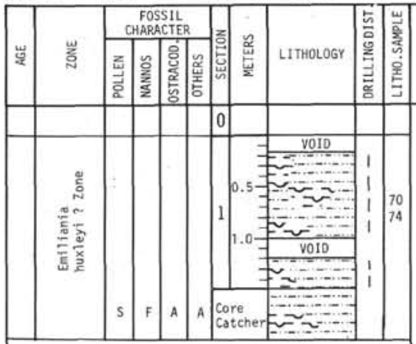
	2-22 to 23	4-17 to 18
Sand	12%	0%
Silt	56%	62%
Clay	32%	38%

<u>Carbonate</u>:

	$CaCO_3$	Corg.
2-122 to 137	10%	1.1%
4-42 to 54	15%	1.9%

Explanatory notes in Chapter 1

Site 380 Hole Core 8 Cored Interval: 66.5-76.0 m



LITHOLOGIC DESCRIPTION

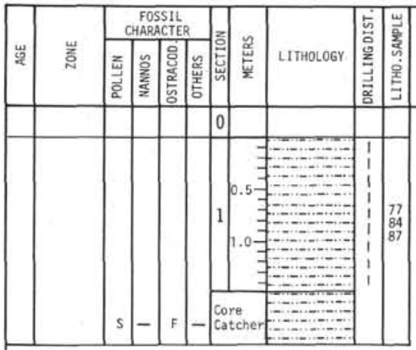
DIATOMACEOUS MUDS

Alternation of olive gray (5Y 4/1), diatom-bearing mud (SS 1-74) and of dark greenish gray (5GY 4/1) mud with less diatoms (SS 1-70).

SS 1-74 cm
20% Quartz and Feldspar
40% Clay
10% Pyrite and opaque
20% Carb.
10% Diatom

SS 1-70 cm
20% Quartz and Feldspar
45% Clay
10% Pyrite
20% Carb.
< 5% Diatom
Tr Nannos

Site 380 Hole Core 9 Cored Interval: 76.0-85.5 m



LITHOLOGIC DESCRIPTION

MUDS

Mainly medium light gray (N5) with sandy silt interlayers.

Muds show cyclic variations in color and in grain size. Clayey, or finer grained in lighter (probably more oxidizing) colors, silty in darker colors, and probably more reducing environment).

Idealized cycle 1-84 to 87 cm

black silty mud (SS 84 cm)
gray mud (SS 77 cm)
light brown clay (SS 87 cm)

SS 84 cm (Black silty mud):
45% Quartz and Feldspar
30% Clay
5% Pyrite
15% Carb.
5% Mica, etc.

SS 87 cm (light brown silty clay):
10% Quartz and Feldspar
80% Clay
5% Pyrite
5% Carb.
Tr Nannos

SS 77 cm (DOMINANT LITHOLOGY):
30% Quartz and Feldspar
50% Clay
5% Heavy minerals
10% Carb.
Tr Nannos

X-ray:

	1-31 to 33	1-39 to 41
Calcite	11%	4%
Dolomite	3%	2%
Quartz	17%	15%
Feldspar	5%	6%
Layered silicates	64%	73%
Carb. bomb	14%	6%

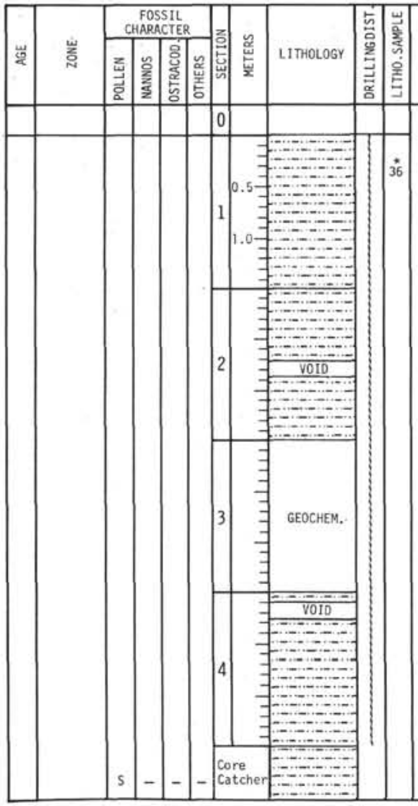
Grain Size:

	1-31 to 33	1-39 to 41
Sand	0%	1%
Silt	45%	29%
Clay	55%	70%

Carbonate:

	CaCO$_3$	Corg.
1-115 to 130	17%	0.4%

Site 380 Hole Core 10 Cored Interval: 85.5-85.0 m



LITHOLOGIC DESCRIPTION

MUDS

Core badly disturbed.
Mixture of:
medium light gray mud (dominant),
black silty mud, and
light brown silty clay.

Apparently a section similar to Core 9 Section 1, but badly disturbed.

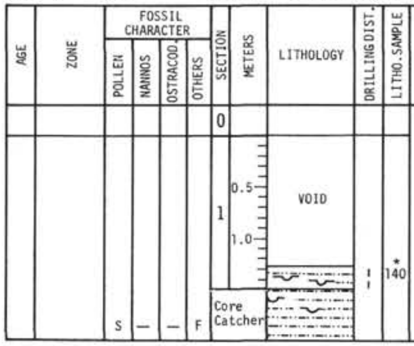
DOMINANT LITHOLOGY:
SS CC
25% Quartz and Feldspar
60% Clay
10% Carb.
< 5% Pyrite and Heavy minerals
Tr Nannos

Carbonate:

	CaCO$_3$	Corg.
2-135 to 138	14%	0.4%

Explanatory notes in Chapter 1

Site 380 Hole Core 11 Cored Interval: 95.0-114.5 m



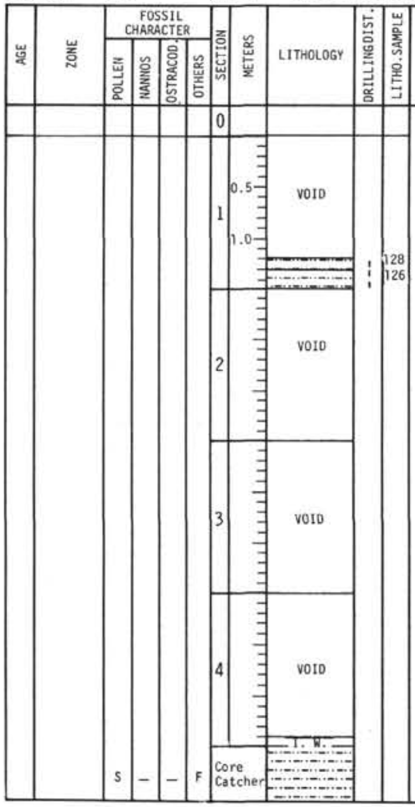
LITHOLOGIC DESCRIPTION

DIATOMACEOUS MUD

Dark greenish gray (5GY 4/1) fairly homogeneous in color and in texture.

DOMINANT LITHOLOGY:
SS 1-140 cm
30% Quartz and Feldspar
50% Clay
10% Pyrite
5% Carb.
10% Diatoms
Tr Nannos

Site 380 Hole Core 12 Cored Interval: 104.5-114.0 m



LITHOLOGIC DESCRIPTION

MUDS AND CLAYS

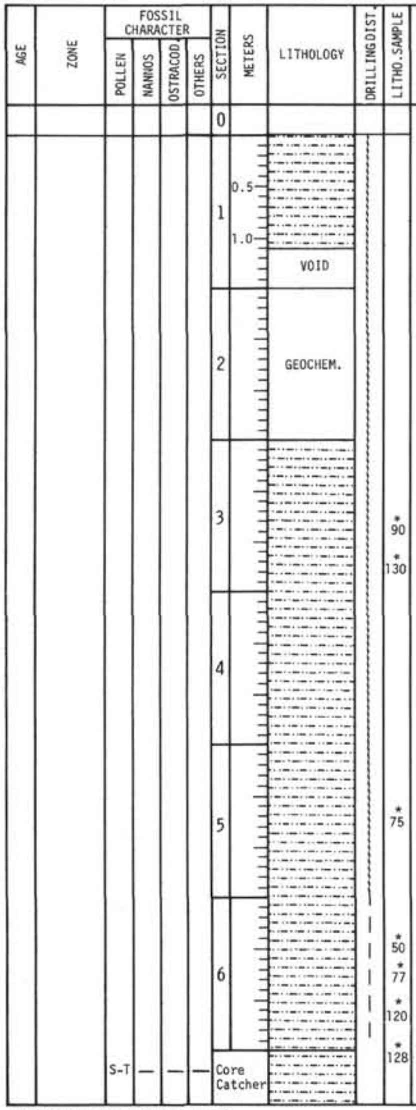
Variation in grain size and in color (dark greenish gray and olive gray). Some diatoms are present but less than above.

DOMINANT LITHOLOGY:
SS 1-128 cm
15% Quartz and Feldspar
65% Clay
5% Pyrite
15% Carb.
Tr Diatoms

MINOR LITHOLOGY:
5% Quartz and Feldspar
80% Clay
5% Carb.
5% Diatoms

(See Core 6 for comparison.)

Site 380 Hole Core 13 Cored Interval: 114.0-123.5 m



LITHOLOGIC DESCRIPTION

MUDS in various shades of gray; greenish gray (5G 6/1) SS 6-77; dark greenish gray (5G 4/1); medium bluish gray (N4); dark gray (N3); and light olive gray, SS 5-75 with laminae of coarser mud (clayey silt, SS 6-148).

DOMINANT LITHOLOGY:
SS 6-77 cm
10% Quartz and Feldspar
80% Clay
< 10% Carb.
2% Pyrite

MINOR LITHOLOGY:
SS 6-14 cm
50% Quartz and Feldspar
35% Clay
10% Mica and Heavy minerals
5% Carb.

MINOR LITHOLOGY:
SS 5-75 cm
15% Quartz and Feldspar
60% Clay
25% Carb.
Tr Nannos

No sample correlation of grain size and colors. Lighter colored may be richer in carbonate (e.g. SS 5-75).

X-ray:

	1-90 to 92	6-128 to 130
Calcite	12%	13%
Dolomite	8%	4%
Quartz	18%	20%
Feldspar	6%	6%
Layered silicates	56%	56%
Carb. bomb	20%	17%

Grain Size:

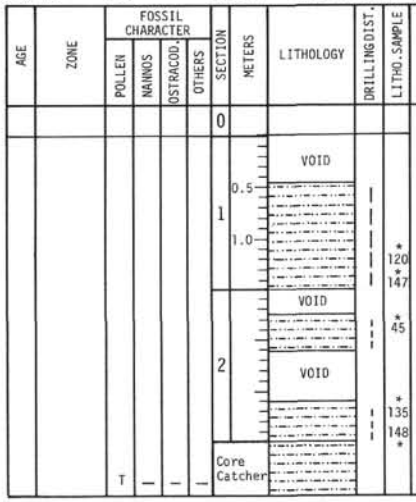
	1-90 to 92	6-128 to 130
Sand	2%	0%
Silt	6%	68%
Clay	38%	32%

Carbonate:

	$CaCO_3$	Corg.
1-0 to 14	19%	0.5%
5-2 to 14	12%	0.5%

Explanatory notes in Chapter 1

Site 380 Hole Core 14 Cored Interval: 123.5 -133.0 m



LITHOLOGIC DESCRIPTION

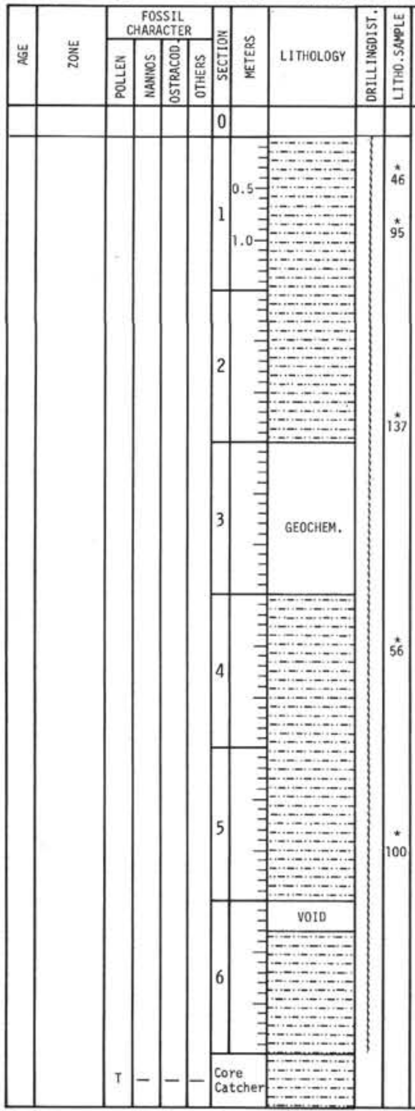
MUDS, SANDY SILTS

Muds in various shades of gray; greenish gray (5GY 5/1); medium dark gray (N4), SS 2-45 with sandy silt intercalations SS 1-120.

DOMINANT LITHOLOGY:
SS 1-147 cm
25% Quartz and Feldspar
60% Clay
5% Pyrite
10% Carb.
Tr Nannos

MINOR LITHOLOGY:
SS 1-120
60% Quartz and Feldspar
10% Clay
5% Pyrite and Opaque
5% Mica and Heavy minerals
20% Carb.

Site 380 Hole Core 15 Cored Interval: 133.0-142.5 m



LITHOLOGIC DESCRIPTION

MUDS, SANDY SILTS

Muds in various shades mixed by drilling with various amount of sandy silt. All barren of diatom (cf Core 14).

MUD
SS 5-100 cm
20% Quartz and Feldspar
60% Clay
5% Pyrite and Opaque
15% Carb.

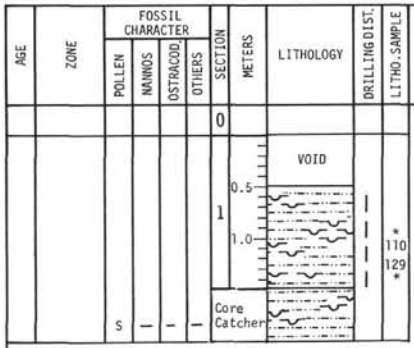
MUD
SS 1-95 cm
15% Quartz and Feldspar
70% Clay
5% Pyrite and Opaque
< 10% Carb.

<u>Carbonate:</u>

	$CaCO_3$	Corg.
1-30 to 45	14%	0.7%

Explanatory notes in Chapter 1

Site 380 Hole Core 16 Cored Interval: 142.5-152.0 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS MUD, SANDY SILT

Greenish gray (5GY 5/1) diatomaceous mud, with intercalations of medium gray (N4) sandy silt.

MUD
SS 1-110 cm
50% Quartz and Feldspar
25% Clay
10% Pyrite and Heavy minerals
 5% Carb.
10% Diatoms

SS 1-129 cm
70% Quartz and Feldspar
10% Mica and Heavy minerals
15% Clay
 5% Pyrite
Tr Carb.

X-ray:

	1-90 to 92
Calcite	4%
Dolomite	4%
Quartz	15%
Feldspar	5%
Layered silicates	72%
Carb. bomb	8%

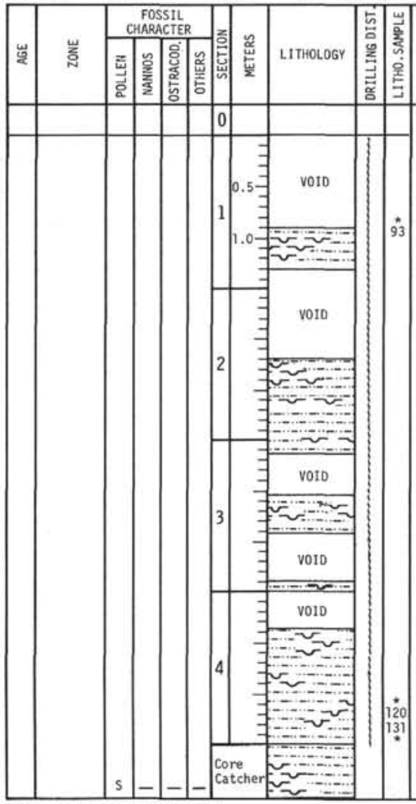
Grain Size:

	1-90 to 92
Sand	2%
Silt	56%
Clay	42%

Carbonate:

	$CaCO_3$	Corg.
1-129 to 145	12%	0.7%

Site 380 Hole Core 17 Cored Interval: 152.0-161.5 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS MUD, SANDY SILT

Dark greenish gray (5GY 4/1), diatom rich mud (SS 4-120) mixed by drilling with greenish gray (5GY 6/1) sandy silt (SS 4-131) (cf Core 16).

DOMINANT LITHOLOGY:
SS 4-120 cm
30% Quartz and Feldspar
40% Clay
10% Pyrite and Heavy minerals
10% Carb.
10% Diatoms

SS 4-131 cm
55% Quartz and Feldspar
10% Clay
10% Pyrite
10% Heavy minerals
 5% Mica
10% Carb.

X-ray:

	4-124 to 126
Calcite	4%
Dolomite	6%
Quartz	20%
Feldspar	6%
Pyrite	Tr
Layered silicates	64%

Grain Size:

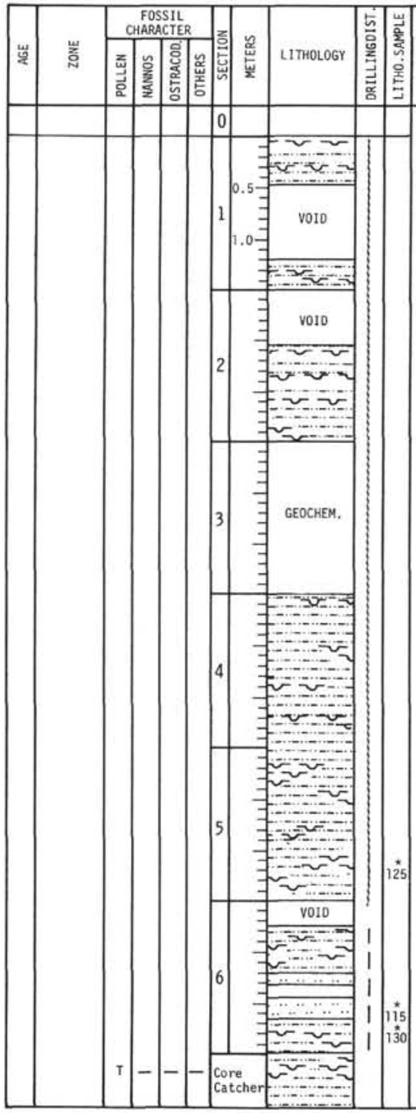
	4-124 to 126
Sand	0%
Silt	65%
Clay	35%

Carbonate:

	$CaCO_3$	Corg.
4-45 to 60	13%	0.8%

Explanatory notes in Chapter 1

Site 380 Hole Core 18 Cored Interval: 161.5-171.0 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS MUD, SANDY SILT

Dark greenish gray (5GY 4/1) diatom mud with sandy silt layers 10-20 cm thick in Section 6.

DIATOMACEOUS MUD (DOMINANT LITHOLOGY):
SS 5-125 cm
15% Quartz and Feldspar
40% Clay
10% Pyrite
15% Carb.
20% Diatoms

SANDY SILT
70% Quartz and Feldspar
10% Heavy minerals
10% Clay
5% Pyrite
5% Carb.

X-ray:

	6-66 to 68
Calcite	7%
Dolomite	5%
Quartz	19%
Feldspar	11%
Layered silicates	58%
Pyrite	Tr
Carb. bomb	12%

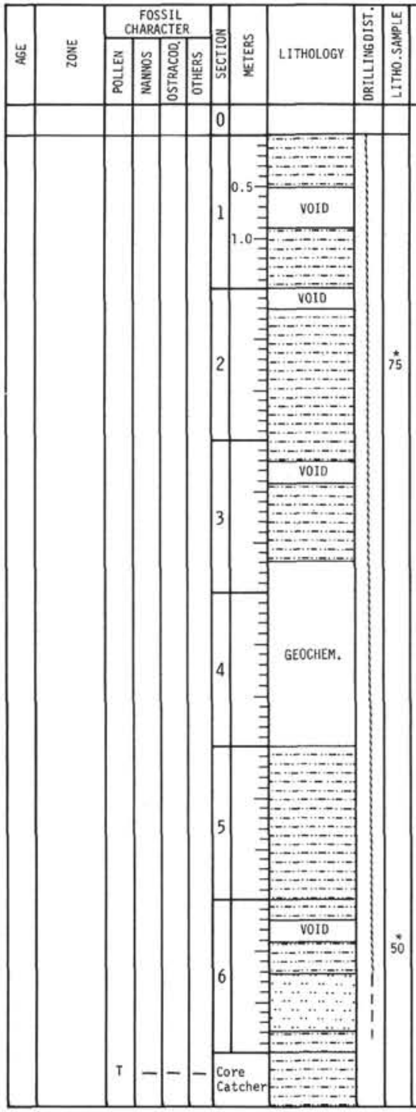
Grain Size:

	6-66 to 68
Sand	0%
Silt	66%
Clay	34%

Carbonate:

	$CaCO_3$	Corg.
5-106 to 125	14%	0.9%
6-130 to 148	10%	1.1%

Site 380 Hole Core 19 Cored Interval: 171.0-180.5 m



LITHOLOGIC DESCRIPTION

MUD, SANDY SILT

Dark greenish gray (5GY 4/1) mud barren of diatoms interbedded with medium light gray sandy silt (N6).

DOMINANT LITHOLOGY:
SS 6-50 cm
15% Quartz and Feldspar
50% Clay
>10% Pyrite
20% Carb.

X-ray:

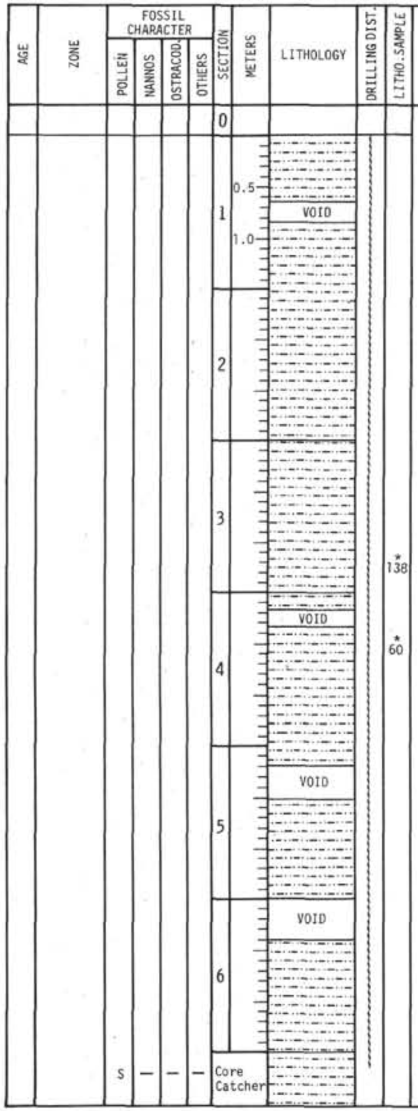
	6-140 to 142
Calcite	8%
Dolomite	5%
Quartz	21%
Feldspar	7%
Layered silicates	59%
Pyrite	Tr
Carb. bomb	13%

Grain Size:

	$CaCO_3$	Corg.
6-58 to 70	12%	0.5%
6-86 to 100	13%	0.8%

Explanatory notes in Chapter 1

Site 380 Hole Core 20 Cored Interval:180.5-190.0 m



LITHOLOGIC DESCRIPTION

MUD

Dark greenish gray (5G 4/1) with slight color variation due to variations in clay and/or pyrite.

DOMINANT LITHOLOGY (Mud):
SS 4-60
10% Quartz and Feldspar
80% Clay
10% Carb.
Tr Nannos

MINOR LITHOLOGY:
SS 2-138 cm
10% Quartz and Feldspar
55% Clay
5% Pyrite
?30% Carb. with dolomite?

X-ray:

	6-84 to 86
Calcite	10%
Dolomite	3%
Quartz	19%
Feldspar	5%
Layered silicates	69%
Siderite	4%
Carb. bomb	13%

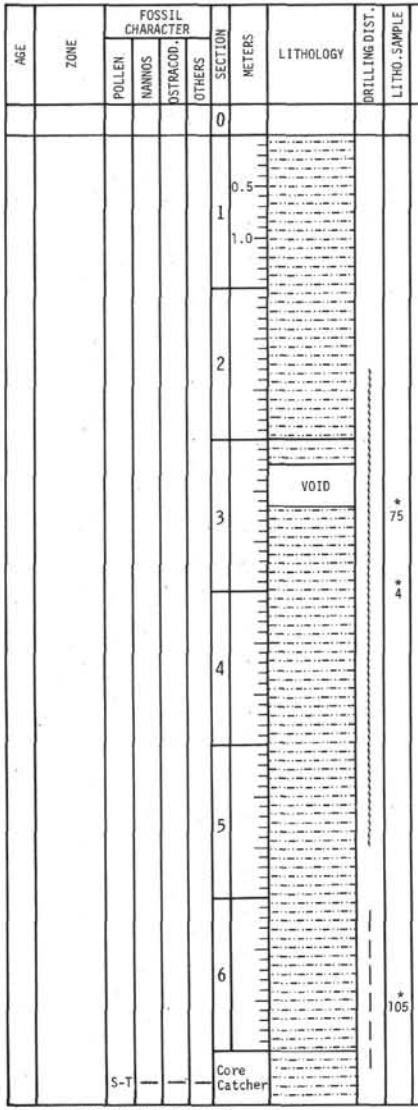
Grain Size:

	6-84 to 86
Sand	1%
Silt	83%
Clay	16%

Carbonate:

	$CaCO_3$	Corg.
6-40 to 50	19%	0.4%

Site 380 Hole Core 21 Cored Interval: 190.0-199.5 m



LITHOLOGIC DESCRIPTION

MUDS

Muds, mainly dark greenish gray (5G 4/1) with one layer light olive gray (SS 4-4).

DOMINANT LITHOLOGY:
SS 3-75 cm
20% Quartz and Feldspar
65% Clay
5% Pyrite, etc.
10% Carb.
Tr Nannos

MINOR LITHOLOGY:
SS 4-4 cm
5% Quartz and Feldspar
< 15% Clay
2% Pyrite
20% Carb. (clay-sized)

X-ray:

	4-45 to 46	5-51 to 53
Calcite	14%	9%
Dolomite	3%	5%
Quartz	12%	24%
Feldspar	6%	9%
Layered silicates	55%	53%
Siderite	10%	0%
Carb. bomb	17%	14%

Grain Size:

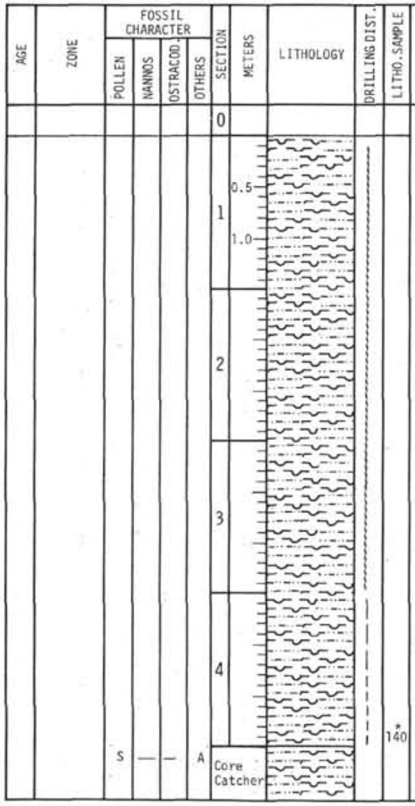
	5-51 to 53
Sand	1%
Silt	72%
Clay	27%

Carbonate:

	$CaCO_3$	Corg.
3-56 to 69	14%	0.5%
6-48 to 61	13%	0.4%

Explanatory notes in Chapter 1

Site 380 Hole Core 22 Cored Interval: 199.5-209.0 m



LITHOLOGIC DESCRIPTION

MUDS, SANDY SILTS, DIATOMACEOUS MUD

Top 3 sections, very badly disturbed mixture of muds and sandy silt, like all other upper sections from Cores 13-21 (except 14, 16). We suspect the mixture a downhole contaminant. Mixture of Core 22 is almost identical to that at Core 21 upper sections.

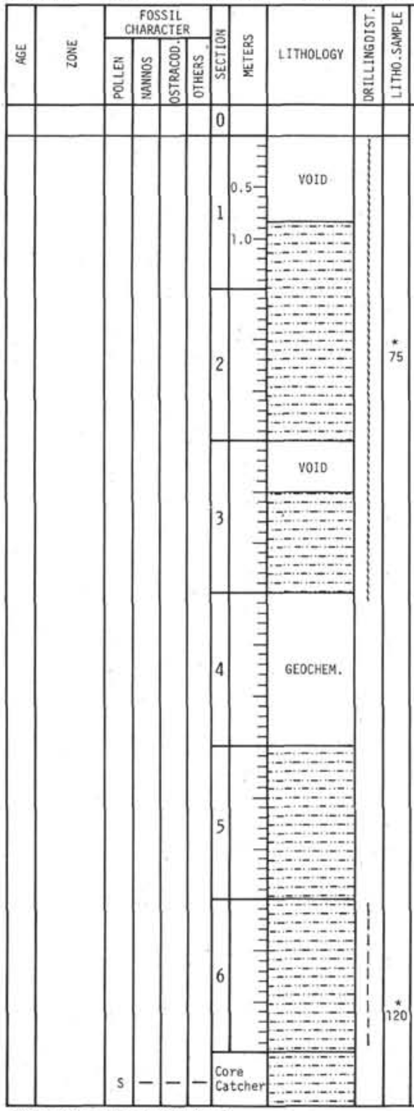
DIATOMACEOUS MUD

In Section 4, greenish gray (5G 4/1) (4-130) grading upward into dark gray (N3), forming thus a centimetric cycle. The muds are often underlain with sharp contact by sandy silt (4-140).

SS 4-130
15% Quartz and Feldspar
50% Clay
20% Carb. (mostly clay size)
10% Diatoms
5% Opaque
Tr Nannos

SS 4-140
90% Quartz and Feldspar
10% Heavy minerals

Site 380 Hole Core 23 Cored Interval: 209.0-218.5 m



LITHOLOGIC DESCRIPTION

MUDS

Top 3 sections are practically identical to top 3 sections of Core 23, but distinctly different from the diatomaceous mud of Section 4, in lithology, core disturbance, etc. These sections are almost certainly downhole contaminants.

Section 6 olive gray (5Y 4/1) mud, with light gray sandy silt pockets.

DOMINANT LITHOLOGY:
SS 6-120
10% Quartz and Feldspar
65% Clay
3% Pyrite
20% Carb.
1% Nannos

X-ray:

	6-70 to 71
Calcite	8%
Dolomite	4%
Quartz	19%
Feldspar	6%
Layered silicates	63%
Siderite	
Carb. bomb	12%

Grain Size:

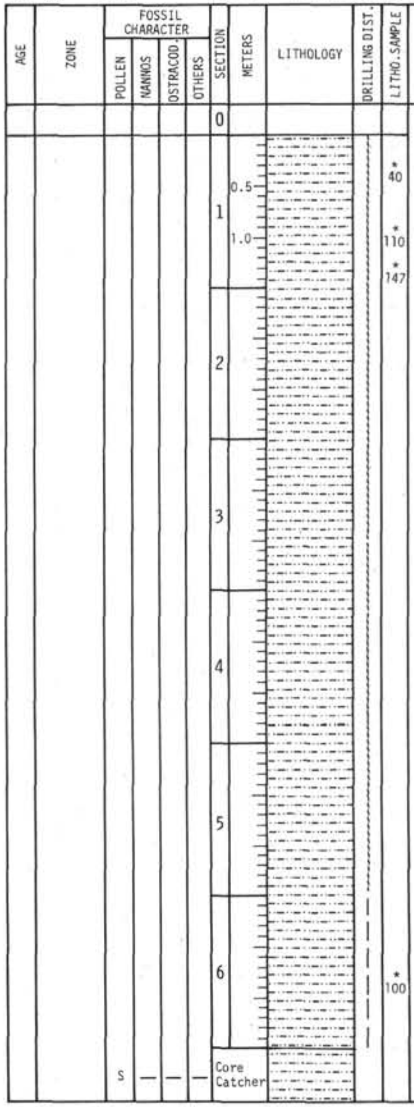
	6-70 to 71
Sand	14%
Silt	50%
Clay	36%

Carbonate:

	$CaCO_3$	Corg.
6-100 to 110	9%	0.4%

Explanatory notes in Chapter 1

Site 380 Hole Core 24 Cored Interval: 218.5-228.0 m



LITHOLOGIC DESCRIPTION

MUDS

Top 5 sections very badly disturbed and Section 6 moderately disturbed.

Except for upper half of Section 1, most sections seem to resemble Section 6 of this core.

Top 5 sections mixture of muds in 3 shades of gray:
olive gray (5Y 4/1) SS 1-110 cm
dark greenish gray (5G 4/1) SS 1-40 cm
greenish gray (5G 6/1) SS 1-147 cm

SS 1-110 cm:
10% Quartz and Feldspar
80% Clay
10% Carb.

SS 1-40 cm
15% Quartz and Feldspar
70% Clay
5% Pyrite
< 10% Carb.

SS 1-147 cm
15% Quartz and Feldspar
60% Clay
20% Carb.
>5% pyrite and heavy minerals

Section 6, mainly olive gray mud, with mottled patches of muds in other colors.

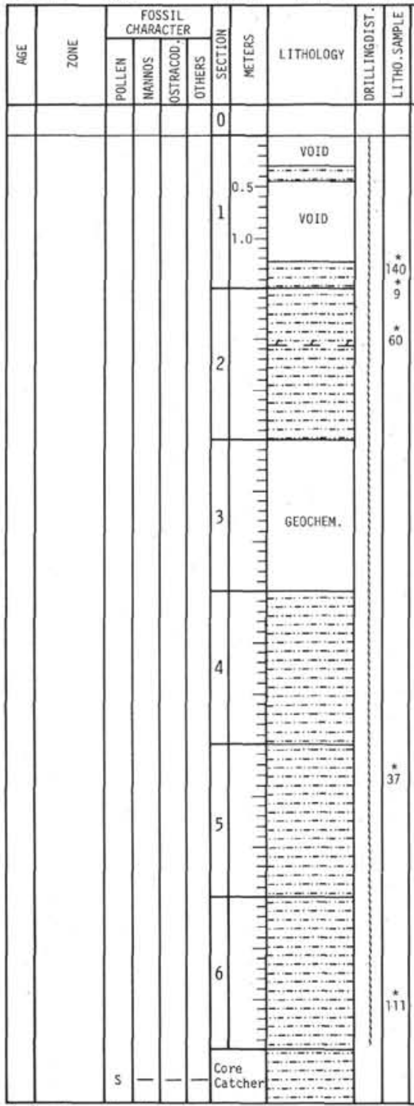
SS 6-100 cm
5% Quartz and Feldspar
70% Clay
5% Pyrite
20% Carb.

X-ray:	Sec. 4	Sec. 6	
	39-41	82-84	144-146
Calcite	10%	9%	7%
Dolomite	3%	1%	5%
Quartz	13%	14%	16%
Feldspar	3%	7%	5%
Layered silicates	61%	69%	67%
Siderite	10%	Tr	Tr
Carb. bomb	13%	10%	12%

Grain Size:	Sec. 4	Sec. 6	
	39-41	82-84	144-146
Sand	0%	0%	0%
Silt	44%	33%	43%
Clay	56%	67%	57%

Carbonate:	$CaCO_3$	Corg.
5-0 to 8	11%	0.4%

Site 380 Hole Core 25 Cored Interval: 228.0-237.5 m



LITHOLOGIC DESCRIPTION

MUDS, CARBONATE LAMINAE

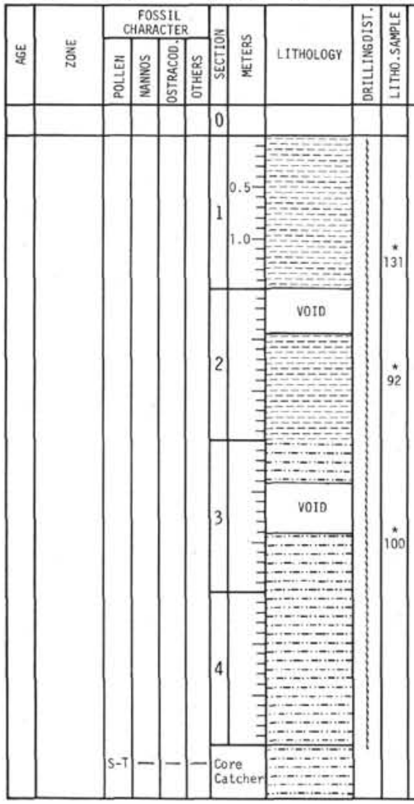
Mixtures of muds, mainly dark greenish gray SS 2-9 cm with minor streak of carb-rich micrite lamina, SS 2-60 cm.

DOMINANT LITHOLOGY:
SS 2-9 cm
15% Quartz and Feldspar
75% Clay
5% Pyrite and Mica
15% Carb.

MINOR LITHOLOGY
SS 2-60 cm
5% Quartz and Feldspar
5% Pyrite and Mica
20% Clay
70% Carb.

Explanatory notes in Chapter 1

Site 380 Hole Core 26 Cored Interval: 237.5-247.0 m



LITHOLOGIC DESCRIPTION

MUDS, CLAYS

"Drilling breccia" in Sections 1 and 2. Pieces of light olive gray (5Y 4/1) clay (SS 2-92 cm) in a dark gray (N5) clay matrix. No diatoms, no carbonates.

The lower 2 sections are gray black (N2) muds, badly disturbed (SS 3-100 cm).

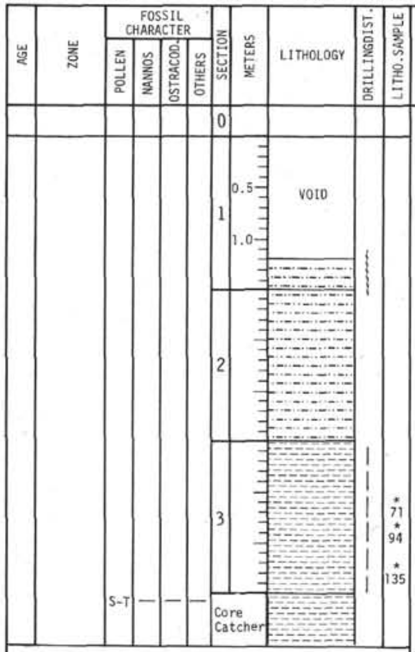
CLAY
SS 2-92 cm
10% Quartz and Feldspar
90% Clay
2% Pyrite

SS 3-100
50% Quartz and Feldspar
40% Clay
5% Pyrite and Opaque
5% Carb.

Carbonate:

	$CaCO_3$	Corg.
4-55 to 65	1%	0.5%

Site 380 Hole Core 27 Cored Interval: 247.0-256.5 m



LITHOLOGIC DESCRIPTION

MUDS, CLAYS, MARLY LAMINAE

Section 1 disturbed muds.

Undisturbed section, mainly clays, layered in various shades of gray. Indistinct cyclic layers from greenish gray (5G 6/1) to greenish black (5GY 2/1). Micrite layer at 3-120 to 140 cm, is greenish gray (5GY 6/1).

Greenish gray clay
SS 3-71 cm
5% Quartz and Feldspar
80% Clay
5% Pyrite
10% Carb.

Greenish black clay
SS 3-94 cm
5% Quartz and Feldspar
50% Clay
45% Carb.

Greenish gray, micrite
SS 3-134 cm
< 5% Quartz and Feldspar
>35% Clay
60% Carb.

X-ray:

	3-19 to 21	3-130 to 132
Calcite	8%	6%
Dolomite	1%	1%
Quartz	20%	4%
Feldspar	6%	1%
Layered silicates	65%	34%
Carb. bomb	9%	61%

Grain Size:

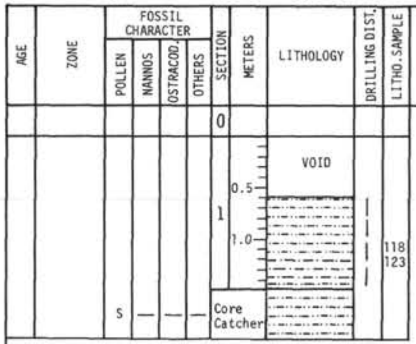
	3-19 to 21	3-130 to 132
Sand	1%	0%
Silt	36%	66%
Clay	63%	34%

Carbonate:

	$CaCO_3$	Corg.
3-1 to 13	10%	0.4%

Explanatory notes in Chapter 1

Site 380 Hole Core 28 Cored Interval: 256.5-265.0 m



LITHOLOGIC DESCRIPTION

MUD, SANDY SILT

Olive gray (5Y 5/1) mud, with intercalated laminae, up to 1 cm thick, of sandy silt.

SS 1-118 cm
[0, 35, 65]
10% Quartz and Feldspar
5% Pyrite, Micas, etc.
65% Clays
15% Carb.
5% Nannos

Coarse layer
SS 1-123 cm
[25, 60, 15]
60% Quartz and Feldspar
12% Micas, Pyrite, Heavy minerals
10% Clay
15% Carb.
3% Nannos

X-ray:

	1-68 to 70
Calcite	13%
Dolomite	4%
Quartz	19%
Feldspar	6%
Layered silicates	58%
Carb. bomb	Tr

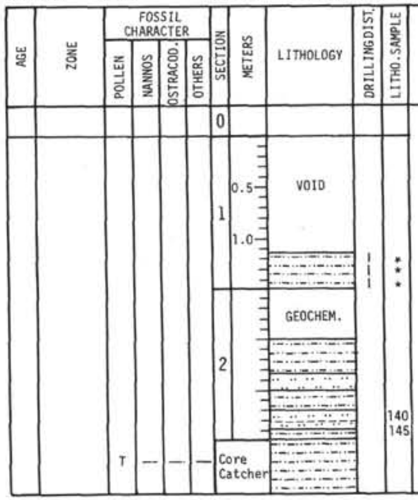
Grain Size:

	1-68 to 70
Sand	0%
Silt	62%
Clay	38%

Carbonate:

	$CaCO_3$	Corg.
1-124 to 126	25%	0.5%
1-134 to 150	20%	0.5%

Site 380 Hole Core 29 Cored Interval: 266.0-275.5 m



LITHOLOGIC DESCRIPTION

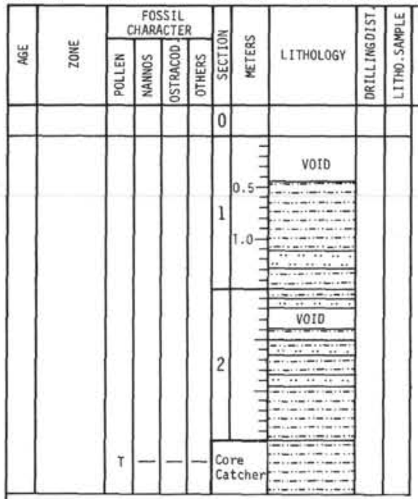
MUDS, TURBIDITE

Muds in various shades of gray related to grain size, with intercalcations of sandy silt deposited by turbidition currents.

Light olive gray
SS 1-117 cm
[0, 30, 70]
10% Quartz and Feldspar
10% Clay
< 5% Heavy minerals and Pyrite
20% Carb.
Tr Nannos

Greenish gray
SS 1-124 cm
[0, 60, 40]
30% Quartz and Feldspar
40% Clay
10% Pyrite and Heavy minerals
20% Carb.
Tr Nannos

Site 380 Hole Core 30 Cored Interval: 275.5-285.0 m



LITHOLOGIC DESCRIPTION

MUDS, TURBIDITE

Muds, olive gray (5Y 4/1) to light olive gray (5Y 6/1) and interbedded sandy silt layers deposited by turbidite, currents. Good evidence of graded bedding.

Mud
SS 1-77 cm
[0, 60, 40]
45% Quartz and Feldspar
40% Clay
5% Pyrite and Heavy minerals
10% Carb.

Bottom, graded bed
SS 1-87 cm
[20, 70, 10]
65% Quartz and Feldspar
10% Clay
10% Mica, Pyrite, Glauconite
< 15% Carb.

(Core undisturbed)

X-ray:

	Sec. 1 73-75	79-81	84-86	89-91
Calcite	4%	6%	8%	6%
Dolomite	1%	4%	5%	4%
Quartz	20%	27%	38%	32%
Feldspar	7%	10%	12%	15%
Layered silicates	68%	50%	35%	42%
Siderite	0%	3%	1%	1%
Carb. bomb	5%	10%	13%	10%

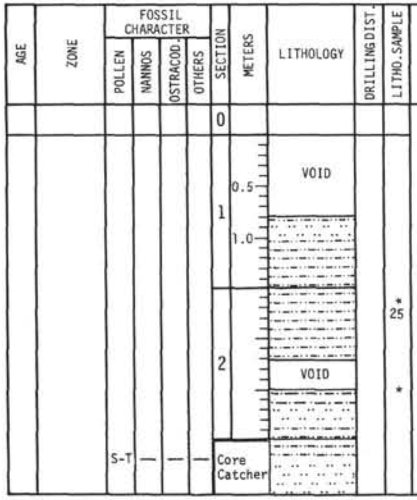
Grain Size:

	Sec. 1 73-75	79-81	84-86	89-91
Sand	0%	1%	4%	4%
Silt	49%	70%	76%	83%
Clay	51%	29%	20%	13%

Carbonate:

	$CaCO_3$	Corg.
1-94 to 110	17%	0.5%

Site 380 Hole Core 31 Cored Interval: 285.0-294.5 m



LITHOLOGIC DESCRIPTION

MUD, TURBIDITE

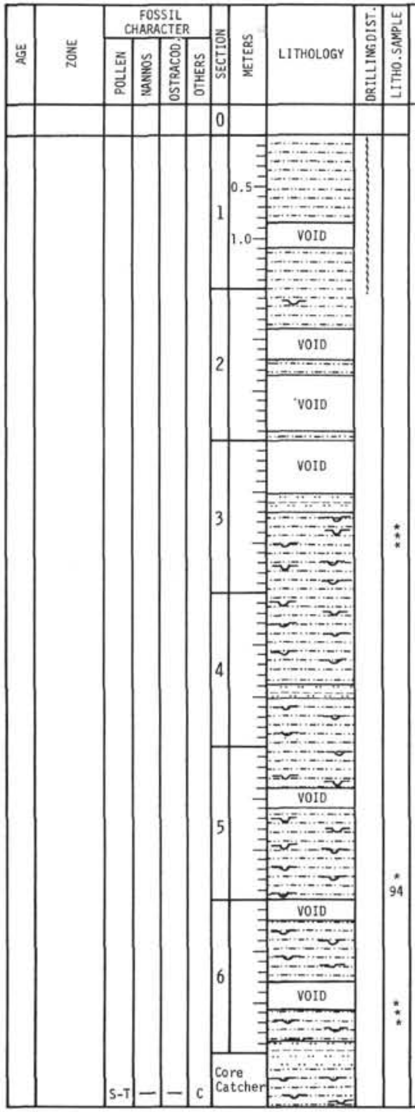
Mud, olive gray (5Y 4/1) with intercalations of sandy silt deposited by turbidity currents.

(Core undisturbed)

DOMINANT LITHOLOGY:
SS (average)
[0, 30, 70]
15% Quartz and Feldspar
60% Clay
5% Pyrite
20% Carb.

Explanatory notes in Chapter 1

Site 380 Hole Core 32 Cored Interval: 294.5-305.0 m



LITHOLOGIC DESCRIPTION

MUDS, DIATOMACEOUS MUD, TURBIDITE

Muds, dark greenish gray (5G 4/1), greenish black (5G 2/1). Color variation attributed to the varying abundance of pyrite with intercalation of sandy silt, deposited by turbidity currents.

Graded unit, 3-90 to 93 cm interval

90 cm	92 cm	93 cm	
15%	30%	50%	Quartz and Feldspar
50%	40%	20%	Clay
20%	5%	3%	Pyrite
2%	1%	2%	Heavy minerals
10%	20%	20%	Carb.
3%	2%	5%	Diatoms

The muds have varying amounts of diatom, from traces to 10%. Diatom-rich layers tend to have an olive shade of gray. Layers 5-10 cm thick of olive and dark gray.

SS 6-114 cm (dark greenish gray)
20% Quartz and Feldspar
55% Clay
10% Pyrite
10% Carb.
5% Diatoms

SS 6-106 cm (olive gray)
10% Quartz and Feldspar
70% Clay
10% Pyrite
< 5% Carb.
10% Diatoms

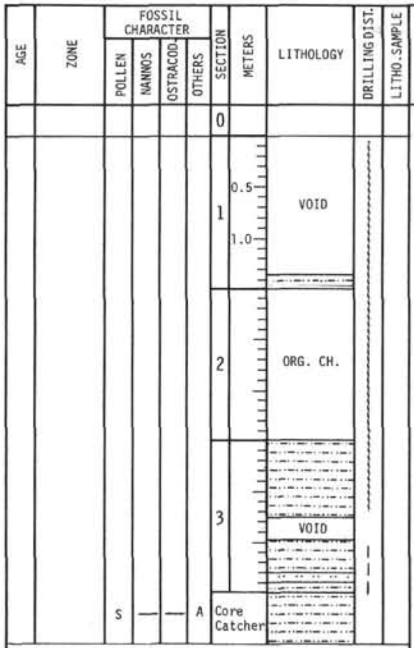
SS 6-116 cm
70% Quartz and Feldspar
5% Clay
15% Pyrite, Heavy minerals, Mica
10% Carb.

X-ray:	Sec. 3		Sec. 4	Sec. 5	
	65-67	85-86	24-26	21-25	146-148
Calcite	3%	7%	5%	5%	5%
Dolomite	8%	3%	3%	3%	5%
Quartz	38%	25%	19%	16%	30%
Feldspar	5%	9%	8%	5%	12%
Layered silicates	46%	56%	65%	70%	48%
Siderite	Tr	0%	0%	0%	0%
Pyrite	0%	0%	0%	1%	0%
Carb. bomb	11%	10%	8%	8%	10%

Grain Size:	Sec. 3		Sec. 4	Sec. 5	
	65-67	85-86	24-26	21-25	146-148
Sand	12%	2%	1%	1%	2%
Silt	61%	42%	52%	61%	84%
Clay	28%	56%	47%	38%	14%

Carbonate:	$CaCO_3$	Corg.
3-70 to 80	10%	0.6%
3-80 to 90	11%	0.6%
5-1 to 10	14%	0.7%

Site 380 Hole Core 33 Cored Interval: 304.0-313.5 m



LITHOLOGIC DESCRIPTION

SILTY MUDS, TURBIDITE

Mud, dark greenish gray (5G 4/1) with sandy silt layers deposited by turbidity currents.

DOMINANT LITHOLOGY:
SS 3-132 cm
[0, 80, 20]
50% Quartz and Feldspar
20% Clay
10% Pyrite
< 5% Heavy minerals
15% Carb.
1% Diatoms

MINOR LITHOLOGY:
SS 3-139 cm
[10, 85, 5]
65% Quartz and Feldspar
5% Clay
10% Pyrite and Heavy minerals
20% Carb.

X-ray:	3-146 to 147
Calcite	7%
Dolomite	6%
Quartz	23%
Feldspar	14%
Layered silicates	50%
Carb. bomb	13%

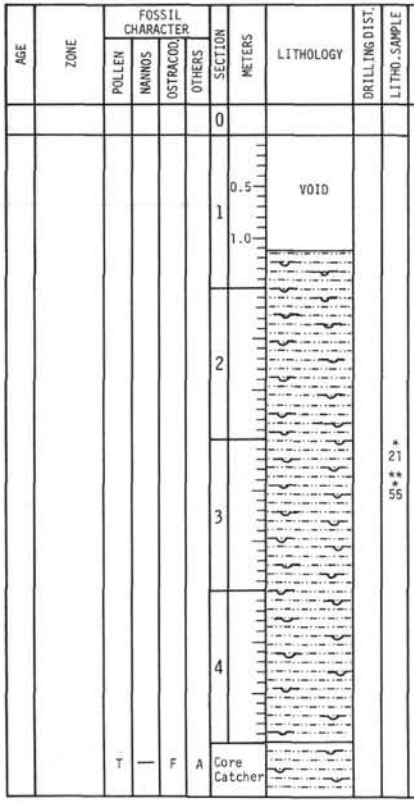
Grain Size:	3-146 to 147
Sand	5%
Silt	69%
Clay	26%

Carbonate:	$CaCO_3$	Corg.
3-95 to 110	12%	0.6%

Site 380, Core 34, 313.5-323.0 m: PRESSURE CORE BARREL, NO RECOVERY.

Explanatory notes in Chapter 1

Site 380 Hole Core 35 Cored Interval: 323.0-332.5 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS MUDS, SANDY SILT

Diatomaceous muds in dark greenish gray and olive gray with sandy silt laminae, more abundant in Section 4.

SS 3-55 cm
20% Quartz and Feldspar
50% Clay
10% Pyrite and Heavy minerals
10% Carb.
10% Diatoms

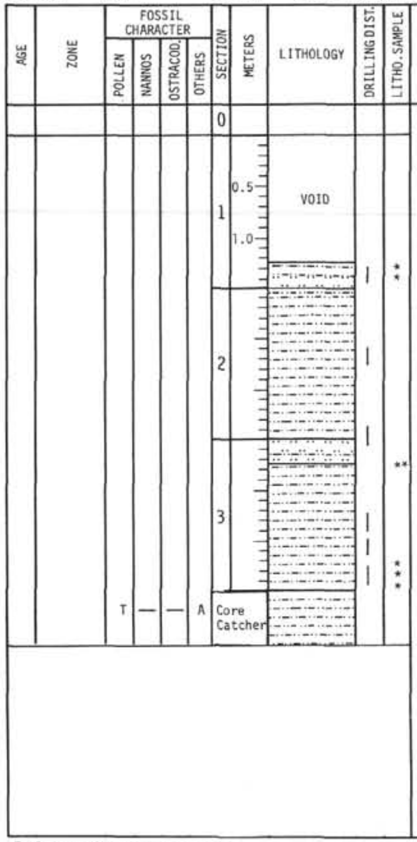
SS 3-21 cm
5% Quartz and Feldspar
50% Clay
10% Pyrite
10% Carb.
35% Diatoms

X-ray:	Sec. 1 137-139	Sec. 2 85-87	Sec. 3 54-57	Sec. 4 67-69
Calcite	10%	8%	9%	6%
Dolomite	10%	4%	6%	3%
Quartz	23%	32%	27%	40%
Feldspar	8%	9%	6%	9%
Layered silicates	49%	46%	52%	41%
Pyrite	20%	1%	Tr	1%
Carb. bomb		12%	15%	9%

Grain Size:	Sec. 1 137-139	Sec. 2 85-87	Sec. 3 54-57	Sec. 4 67-69
Sand	0%	0%	20%	1%
Silt	64%	57%	55%	41%
Clay	36%	43%	25%	58%

Carbonate:	$CaCO_3$	Corg.
1-111 to 123	13%	0.9%
3-19 to 42	9%	1.6%

Site 380 Hole Core 36 Cored Interval: 332.5-342.0 m



LITHOLOGIC DESCRIPTION

ARAGONITIC MUDS, SANDY SILT

Muds, olive gray (5Y 4/1), dark greenish gray (5G 4/1).

Diatoms rare, but aragonite needles were recognized, precipitation interstitially? with numerous, sandy silt, and a few silty sand, laminae.

DOMINANT LITHOLOGY:
[0, 65, 35]
20% Quartz and Feldspar
45% Clay and org.
15% Pyrite
15% Carb.
5% Aragonite

MINOR LITHOLOGY
[60, 35, 5]
65% Quartz and Feldspar
10% Pyrite and Heavy minerals and Glauconite
< 5% Clay
10% Carb.
10% Aragonite
Tr Diatom

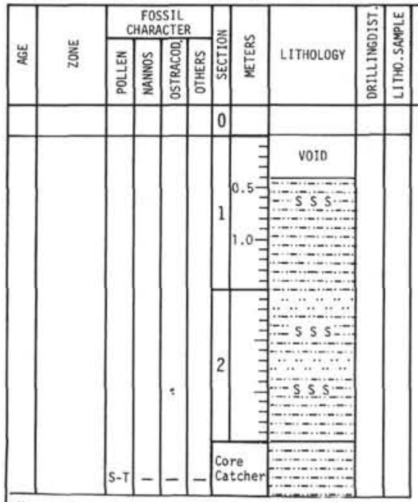
X-ray:	Sec. 2 70-72	102-103	Sec. 3 123-125
Calcite	12%	9%	15%
Dolomite	4%	2%	3%
Quartz	16%	15%	15%
Feldspar	7%	6%	6%
Layered silicates	61%	68%	61%
Siderite	0%	0%	Tr
Carb. bomb	16%	11%	18%

Grain Size:	Sec. 2 70-72	102-103	Sec. 3 123-125
Sand	0%	1%	1%
Silt	67%	56%	62%
Clay	33%	43%	37%

Carbonate:	$CaCO_3$	Corg.
2-28 to 36	12%	1.4%

Explanatory notes in Chapter 1

Site 380 Hole Core 37 Cored Interval: 342.0-351.5 m



LITHOLOGIC DESCRIPTION

MUDS

Mud, greenish gray (5G 5/1) or dark greenish gray (5GY 4/1) grading to dark gray (N3). The laminations are indistinct, 1-2 cm thick. A few sandy silt intercalations are present.

Three layers of SIDERITIC MUD light olive gray (5Y 6/1).

DOMINANT LITHOLOGY (Mud):
[0, 35, 65]
15% Quartz and Feldspar
65% Clay
5% Pyrite
15% Carb.
Tr Nannos

MINOR LITHOLOGY (Sideritic mud):
SS 1-63 cm
60% Clay
40% Siderite (clay-sized)

SS 2-44 cm
5% Quartz and Feldspar
5% Mica and Pyrite
35% Clay
5% Carb.
50% Siderite

X-ray:

	1-60 to 62	2-41 to 43
Caclite	7%	8%
Dolomite	3%	2%
Quartz	4%	4%
Feldspar	3%	3%
Layered silicates	37%	49%
Siderite	46%	34%
Carb. bomb	10%	10%

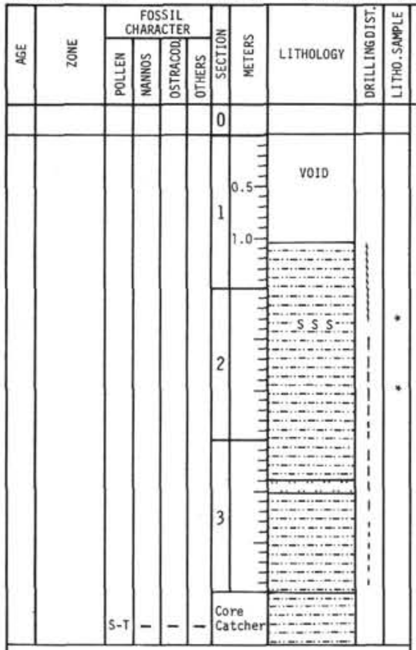
Grain Size:

	1-60 to 62	2-41 to 43
Sand	0%	0%
Silt	86%	84%
Clay	14%	16%

Carbonate:

	$CaCO_3$	Corg.
1-73 to 83	8%	0.5%

Site 380 Hole Core 38 Cored Interval: 351.5-361.0 m



LITHOLOGIC DESCRIPTION

MUDS, SIDERITIC MUDS, SANDY SILTS

Mud, greenish gray (5GY 5/1), marly with a few SIDERITIC MUD and sandy silt intercalations.

SIDERITIC MUD light olive gray (5Y 5/2) at 2-28 to 32 cm interval.

DOMINANT LITHOLOGY (Mud, marly):
SS 2-100 cm
10% Quartz and Feldspar
60% Clay
Tr Pyrite
30% Carb. and Siderite

MINOR LITHOLOGY (Sideritic mud):
SS 2-30 cm
10% Quartz and Feldspar
50% Clay
< 5% Pyrite and Heavy minerals
40% Siderite (clay-sized)

X-ray:

	2-24 to 26	2-30 to 32
Calcite	10%	10%
Dolomite	4%	2%
Quartz	17%	9%
Feldspar	6%	4%
Layered silicates	63%	46%
Siderite	0%	29%
Carb. bomb	14%	12%

Grain Size:

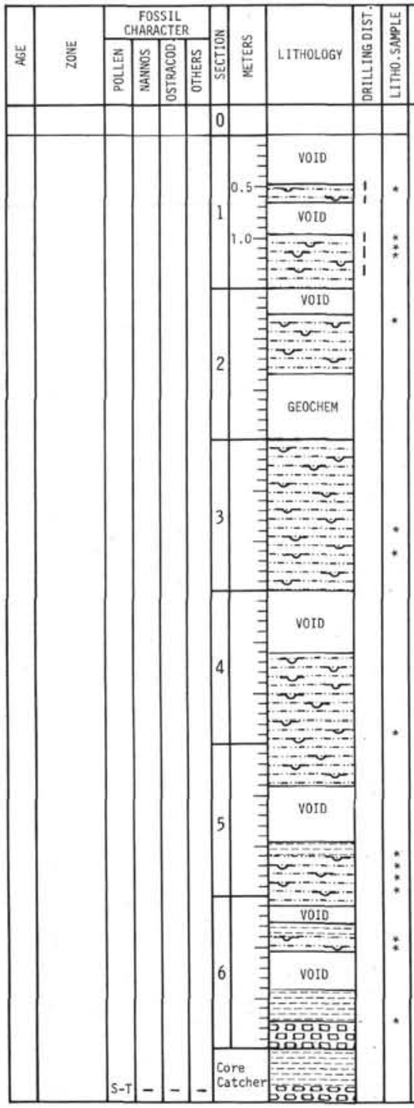
	2-24 to 26	2-30 to 32
Sand	0%	1%
Silt	56%	71%
Clay	44%	28%

Carbonate:

	$CaCO_3$	Corg.
2-73 to 85	12%	0.4%

Explanatory notes in Chapter 1

Site 380 Hole Core 39 Cored Interval: 361.0-370.5 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS MUD, CLAYEY DIATOMACEOUS OOZE, BLACK MUD, MARL

Diatomaceous muds, mainly olive gray (5Y 3/2) to moderate olive brown (5Y 4/4); diatoms increase from 3% in SS 1-103 cm to a maximum of 55% in SS 5-135 cm. Cyclic laminations from greenish-gray diatom mud to olive brown clayed diatomaceous ooze were recognized, particularly in Section 5 where numerous brown black (5YR 2/1) organic-rich layers are seen. Section 6-125 to 148 cm is a light gray (N7) marl. A few sandy silt layers are present.

DIATOMACEOUS MUD:
SS 5-138 cm
10% Quartz and Feldspar
40% Clay
10% Pyrite
25% Carb.
15% Diatoms

CLAYEY DIATOMACEOUS OOZE:
SS 5-135 cm
5% Quartz and Feldspar
35% Clay
2% Pyrite
3% Carb.
55% Diatoms

ORGANIC-RICH CLAY:
SS 6-50 cm
75% Clay with organic matter
10% Pyrite
5% Carb.
5% Diatom
5% Quartz and Feldspar

CLAYEY MICRITE:
10% Quartz and Feldspar
40% Clay
50% Carb., mainly silt-sized calc.

X-ray:	Sec. 2	Sec. 3	Sec. 5	
	39-40	46-48	132-134	136-138
Calcite	9%	11%	0%	0%
Dolomite	Tr	3%	0%	0%
Quartz	13%	16%	12%	4%
Feldspar	5%	4%	5%	2%
Layered silicates	73%	76%	80%	84%
Siderite	0%	Tr	3%	10%
Pyrite	0%	0%	0%	0%

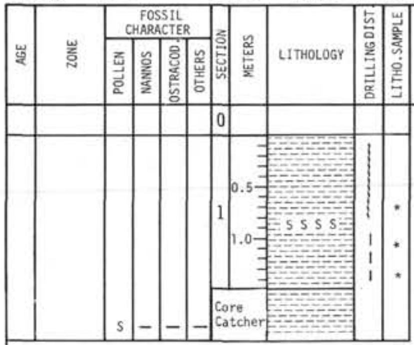
	Sec. 6				
	95-97	100-102	112-114	125-127	138-140
Calcite	0%	65%	58%	75%	79%
Dolomite	0%	0%	Tr	0%	0%
Quartz	20%	4%	7%	2%	3%
Feldspar	5%	1%	2%	Tr	Tr
Layered silicates	74%	30%	33%	23%	18%
Siderite	0%	0%	0%	0%	0%
Pyrite	1%	0%	0%	0%	0%

Grain Size:	Sec. 2	Sec. 3	Sec. 5	
	39-40	46-48	132-134	136-138
Sand	1%	1%	4%	1%
Silt	60%	64%	58%	69%
Clay	39%	35%	38%	30%

	Sec. 6				
	95-97	100-102	112-114	125-127	138-140
Sand	0%	1%	1%	1%	1%
Silt	64%	48%	49%	52%	66%
Clay	36%	51%	50%	47%	33%

Carbonate:	$CaCO_3$	Corg.
1-48 to 62	6%	0.5%

Site 380 Hole Core 40 Cored Interval: 370.5-380.0 m



LITHOLOGIC DESCRIPTION

BROWNISH CLAY

Clay, in shades of brown (5YR 4/1) with a few silty layers and a sideritic clay lamina.

DOMINANT LITHOLOGY (Clay):
SS 1-138 cm
10% Quartz and Feldspar
80% Clay
2% Pyrite
5% Carb.
3% Nannos

MINOR LITHOLOGY (Sideritic clay):
SS 1-80 cm
5% Quartz and Feldspar
40% Clay
3% Pyrite
5% Carb.
45% Siderite (clay sized)

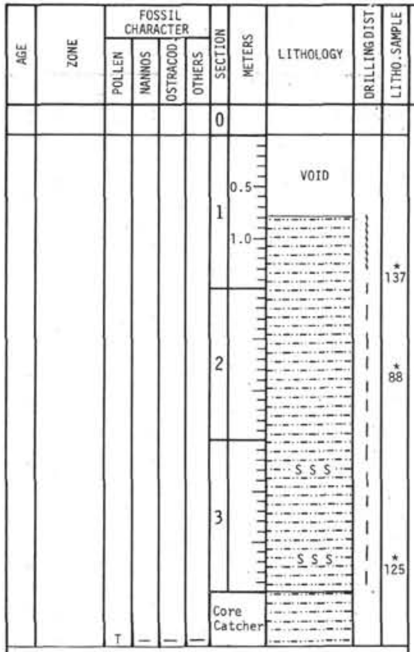
Grain Size:	Sec. 1			
	63-65	80-82	117-118	134-136
Sand	3%	0%	0%	12%
Silt	16%	84%	21%	20%
Clay	81%	16%	79%	67%

Carbonate:	$CaCO_3$	Corg.
1-120 to 135	8%	0.4%

X-ray:	Sec. 1			
	63-65	80-82	117-118	134-136
Calcite	9%	7%	11%	7%
Dolomite	1%	3%	1%	1%
Quartz	12%	11%	11%	14%
Feldspar	4%	3%	4%	4%
Layered silicates	74%	44%	73%	74%
Siderite	Tr	32%	Tr	Tr
Carb. bomb	10%	10%	12%	8%

Explanatory notes in Chapter 1

Site 380 Hole A Core 1 Cored Interval: 332.5-342.0 m



LITHOLOGIC DESCRIPTION

MUDS, SIDERITIC MUDS
(cf 380 C-37)

Muds, diatomaceous in part, or rich in pyrite or organics, in various shades of gray: olive gray (5Y 4/1), dark greenish gray (5GY 4/1), and bluish gray (5B 5/1) with 2 sideritic layers in Section 3.

Indistinct cycles (~1 cm thick) of light grading to darker gray mud well recognized especially in Section 2, 110 to 150 cm.

SS 1-137 cm (Pyrite rich):
[0, 65, 35]
35% Quartz and Feldspar
35% Clay
15% Pyrite
15% Carb.
Tr Diatoms

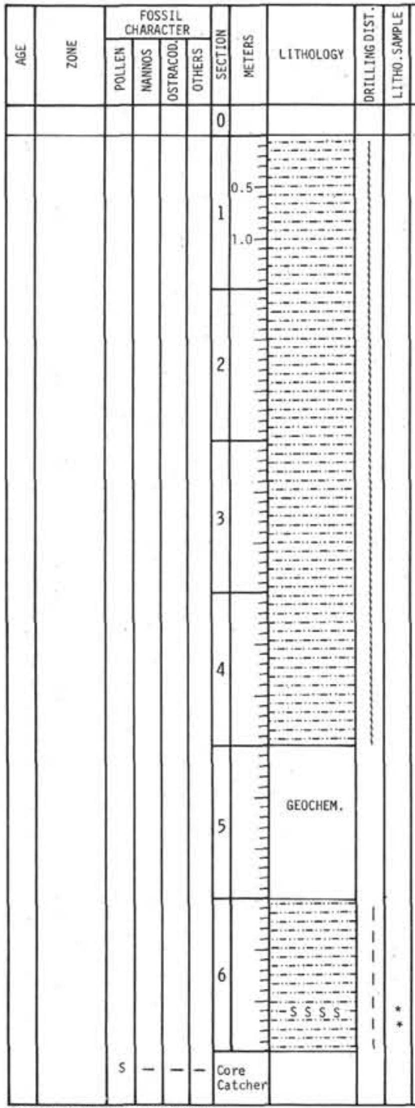
SS 2-88 cm (Organic rich):
[0, 25, 75]
5% Quartz and Feldspar
75% Clay and Organic
10% Pyrite
5% Carb.
5% Diatoms

SS 3-125 cm:
[0, 30, 70]
< 10% Quartz and Feldspar
5% Pyrite and Heavy minerals
65% Clay
10% Carb.
2% Nannos

X-ray:	Sec. 2		Sec. 3		
	86-88	108-109	33-34	42-44	111-113
Calcite	12%	44%	12%	0%	14%
Dolomite	3%	0%	3%	0%	0%
Quartz	13%	7%	11%	11%	5%
Feldspar	8%	3%	6%	7%	3%
Layered silicates	60%	44%	58%	81%	40%
Siderite	0%	0%	10%	0%	38%
Pyrite	2%	0%	0%	0%	0%
Carb. bomb	15%	44%	15%	0%	0%

Grain Size:	3-33 to 34	3-111 to 113
Sand	0%	3%
Silt	9%	67%
Clay	91%	30%

Site 380 Hole A Core 2 Cored Interval: 342.0-351.5 m



LITHOLOGIC DESCRIPTION

MUDS, SIDERITIC MUD
(cf 380 - Core 38)

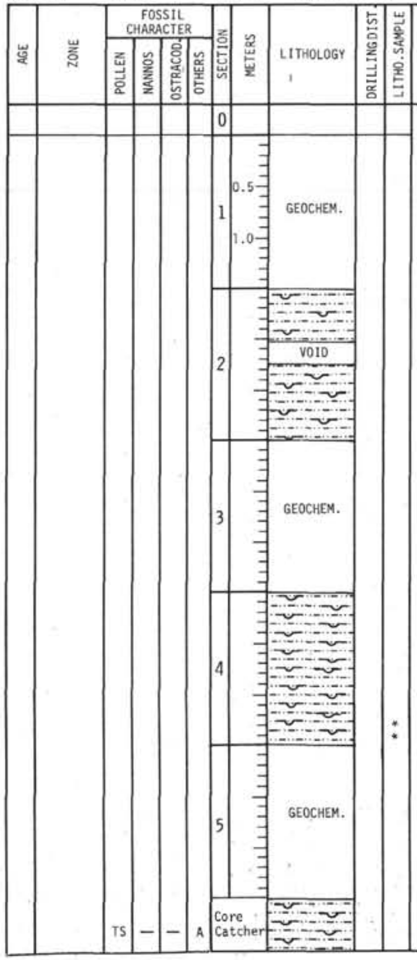
Upper Sections 1 to 4 badly disturbed, muds, olive gray or dark greenish gray. Section 6 muds olive gray or dark greenish gray.

DOMINANT LITHOLOGY:
SS 6-114 cm
[0, 15, 85]
5% Quartz and Feldspar
80% Clay
10% Carb.
< 5% Pyrite, etc.

MINOR LITHOLOGY:
SS 6-105 cm
5% Quartz and Feldspar
45% Clay
< 5% Carb.
45% Siderite (clay size)
1% Pyrite

Explanatory notes in Chapter 1

Site 380 Hole A Core 3 Cored Interval: 351.5-361.0 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS MUDS AND OOZES

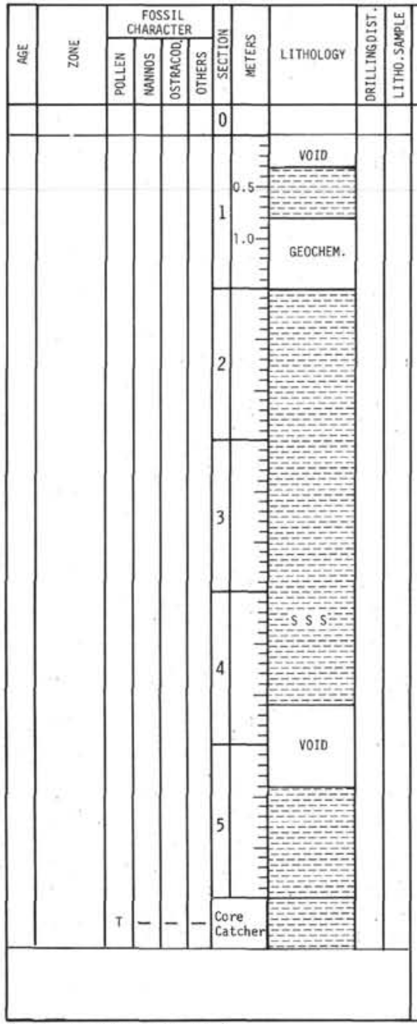
Diatomaceous muds, olive gray (5Y 6/1), or greenish gray (5G 5/1), grading upward into olive gray (5Y 6/1) diatom oozes in some layers. Numerous thin laminae of sandy silt.

DIATOMACEOUS MUD:
SS 4-140 cm
[0, 70, 30]
5% Quartz and Feldspar
30% Clay
10% Pyrite
2% Mica and Heavy minerals
3% Carb.
50% Diatoms

DIATOMACEOUS OOZE:
SS 4-142 cm
[0, 80, 20]
5% Quartz and Feldspar
20% Clay
1% Pyrite
4% Carb.
70% Diatoms

Carbonate:	$CaCO_3$	Corg.
2-74 to 87	9%	1.3%

Site 380 Hole A Core 4 Cored Interval: 361.0-370.5 m



LITHOLOGIC DESCRIPTION

CLAYS (varve-like), SIDERITE

Laminated clay. Individual laminae are 1-2 mm thick composed of: pale brown (5YR 5/2) and light olive gray (5Y 5/2). Every 5-10 cm intervals the gray layers range up to 1-2 cm thick. Gray layers predominate in Section 2. Section 2 122 cm and Section 2 130 cm two laminae of nannofossil oozes, but nannos are all reworked from Maastrichtian. Section 4 includes a siderite layer about 5 cm thick (disturbed by drilling, rotated and perhaps overturned). Laminations are indistinct in Section 5.

Average Composition of brown clays:
[0, 20, 80]
10% Quartz and Feldspar
80% Clay
2% Mica
2% Pyrite
5% Carbonate
1% Nannos

Average composition of gray clays:
[0, 15, 85]
>5% Quartz and Feldspar
85% Clay
4% Pyrite and Heavy minerals
5% Carbonate
1% Nannos

SIDERITE:
SS 4-22 cm
2% Quartz and Feldspar
95% Siderite, clay-sized
3% Pyrite and Carb.

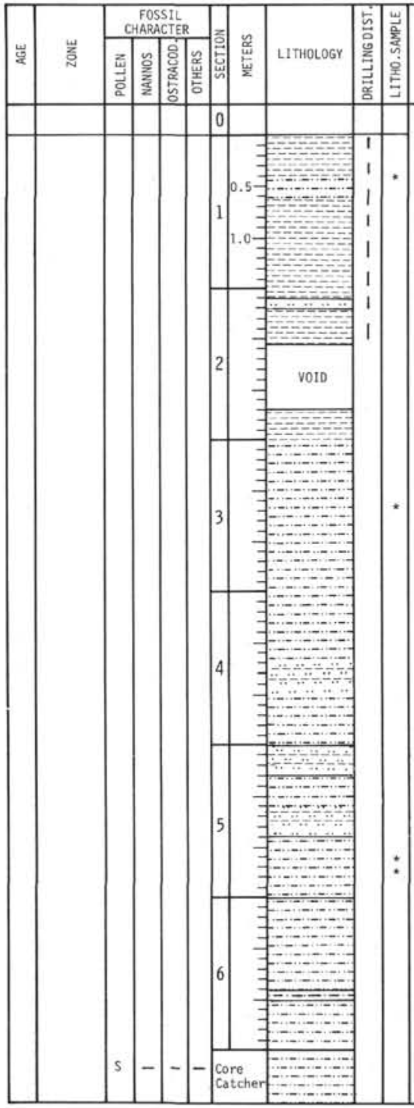
X-ray:	Sec. 1		Sec. 2		Sec. 4
	46-47	54-55	78-80	106-108	122-123
Calcite	9%	11%	10%	9%	7%
Dolomite	1%	7%	0%	3%	3%
Quartz	12%	36%	15%	10%	5%
Feldspar	4%	5%	15%	3%	3%
Layered silicates	73%	41%	60%	71%	36%
Pyrite	0%	0%	0%	1%	0%
Siderite	0%	0%	0%	0%	46%
Carb. bomb	10%	18%	10%	12%	10%

Grain Size:	Sec. 2		Sec. 4
	78-80	106-108	122-123
Sand	0%	0%	0%
Silt	61%	14%	80%
Clay	39%	86%	20%

Carbonate:	$CaCO_3$	Corg.
1-32 to 45	10%	0.3%
5-38 to 51	11%	0.3%

Explanatory notes in Chapter 1

Site 380 Hole A Core 5 Cored Interval: 370.5-380.0 m



LITHOLOGIC DESCRIPTION

MUDS, CLAYS, TURBIDITES

Sections 1 and 2 include varve-like clays as Core 4 grading downward to greenish gray mud in Sections 3, 4, and 5, where faint laminations were recognized in some intervals. Burrows at bottom of Section 5. Turbidite laminae of sandy silt are present in Sections 2 to 5, most common in Section 5.

SS 1-44 cm (Brown clay):
[0, 20, 80]
10% Quartz and Feldspar
75% Clay
2% Pyrite
10% Carb.
3% Nannos

SS 5-125 cm (Greenish gray mud):
[0, 65, 35]
40% Quartz and Feldspar
15% Mica
40% Clay
5% Pyrite and Heavy minerals
Tr Carb.

SS 5-129.5 (Black clay):
[0, 20, 80]
5% Quartz and Feldspar
80% Clay
15% Pyrite
Tr Carb. and Nannos

X-ray:

	3-103 to 105	5-48 to 50
Calcite	7%	5%
Dolomite	2%	0%
Quartz	16%	13%
Feldspar	6%	5%
Layered silicates	69%	77%
Siderite	0%	Tr
Carb. bomb	9%	5%

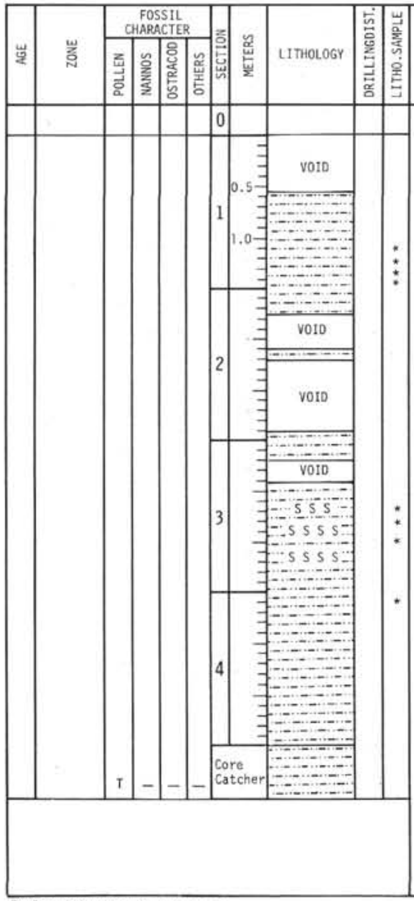
Grain Size:

	3-103 to 105	5-48 to 50
Sand	0%	11%
Silt	26%	19%
Clay	74%	70%

Carbonate:

	$CaCO_3$	Corg.
4-61 to 74	12%	0.3%

Site 380 Hole A Core 6 Cored Interval: 380.0-389.5 m



LITHOLOGIC DESCRIPTION

MUDS, SIDERITIC MUD, SANDY SILT

Muds, laminated in part, in various shades of gray: dark greenish gray (5G 4/1), dark greenish gray (N4), and black (N1).

With a few laminae of light olive gray siderite muds (Section 3) and light gray silty layers.

The dominant lithology is more silty than varved clay, but fewer silty layers are present.

DOMINANT LITHOLOGY:
15-20% Quartz and Feldspar
40-60% Clay
5-30% Carb.
5-10% Pyrite, etc.

MINOR LITHOLOGY (Siderite mud):
SS 3-75 cm
[0, 10, 90]
3% Quartz and Feldspar
50% Clay
2% Pyrite, etc.
5% Carb.
40% Siderite (clay sized)

MINOR LITHOLOGY (Pyrite mud):
SS 4-8 cm
[0, 60, 40] black
15% Quartz and Feldspar
30% Clay
30% Pyrite
25% Carb.

X-ray:

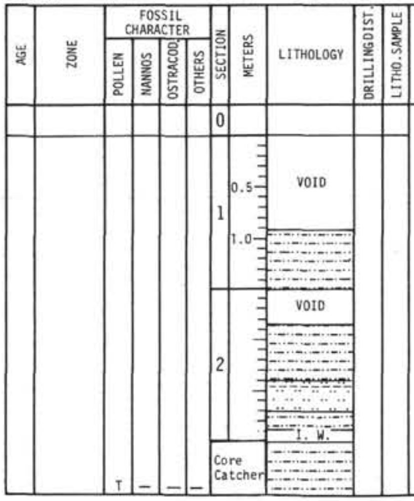
	3-82 to 83	3-101 to 102
Calcite	22%	24%
Dolomite	Tr	1%
Quartz	10%	12%
Feldspar	5%	5%
Layered silicates	52%	57%
Siderite	6%	0%
Carb. bomb	22%	25%

Carbonate:

	$CaCO_3$	Corg.
3-106 to 119	24%	0.8%
4-0 to 18	19%	0.6%

Explanatory notes in Chapter 1

Site 380 Hole A Core 7 Cored Interval: 389.5-399.0 m



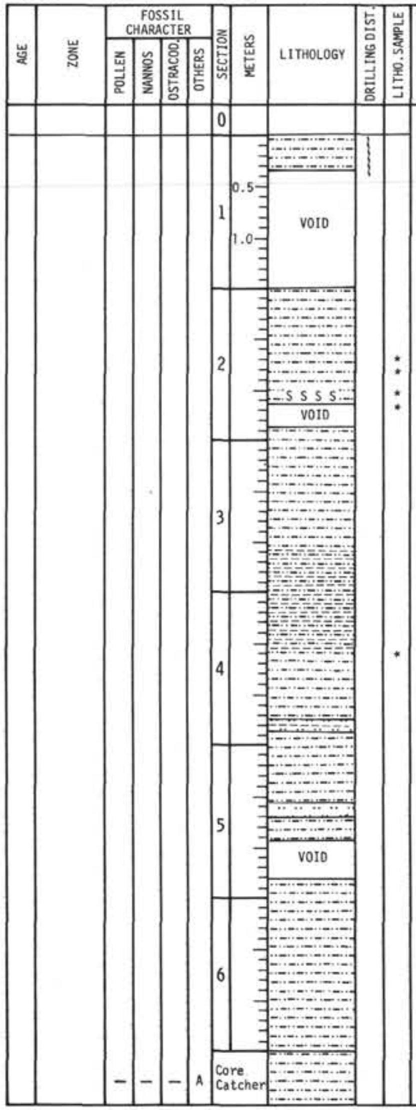
LITHOLOGIC DESCRIPTION

MUDS

Muds, in various shades of gray with instinct laminations. Similar to Section 4 of Core 6.

Thick turbidite bed in Section 2 medium bluish gray sandy silt.

Site 380 Hole A Core 8 Cored Interval: 399.0-408.5 m



LITHOLOGIC DESCRIPTION

MUDS, VARVES, SANDY SILT, SIDERITE MUD

Muds in various shades of gray: medium dark gray (N4), greenish gray (5GY 6/1), and olive gray (5Y 4/2), with a few laminated sandy silt and siderite mud intercalations.

The mud is laminated, with typical varve-like structure. Individual laminae are alternately olive gray (5Y 3/2) and light olive gray (5Y 5/2), and has an aggregate thickness of about 2-5 mm.

Mud:
SS 2-66 cm
[0, 30, 70]
20% Quartz and Feldspar
70% Clay
10% Carb.

Clay:
SS 2-63 cm
[0, 10, 90]
< 5% Quartz and Feldspar
90% Clay
3% Pyrite
3% Carb.

Sideritic mud:
SS 2-110 cm
8% Quartz and Feldspar
85% Clay and Siderite
2% Pyrite
5% Calcite

X-ray:

	3-94 to 96	5-148 to 150
Calcite	10%	8%
Dolomite	1%	0%
Quartz	8%	4%
Feldspar	4%	3%
Layered silicates	77%	33%
Siderite	11%	52%
Carb. bomb		8%

Grain Size:

	3-94 to 96	5-148 to 150
Sand	0%	0%
Silt	9%	87%
Clay	91%	13%

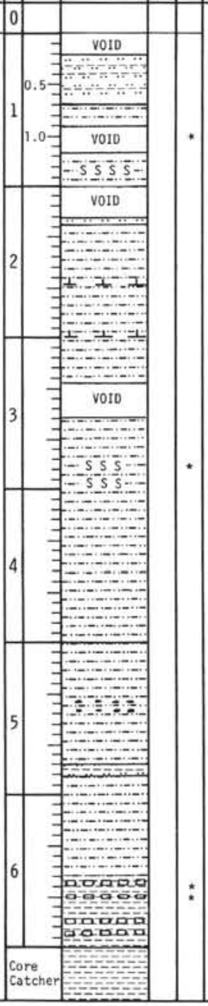
Carbonate:

	$CaCO_3$	Corg.
4-129 to 150	6%	0.7%

Explanatory notes in Chapter 1

Site 380 Hole A Core 9 Cored Interval: 408.5-418.0 m

AGE	ZONE	FOSSIL CHARACTER POLLEN	FOSSIL CHARACTER NANNOS	FOSSIL CHARACTER OSTRACOD.	FOSSIL CHARACTER OTHERS	SECTION
		S	—	—	A	Core Catcher



LITHOLOGIC DESCRIPTION

MUDS, SEEKREIDE, VARVES, TURBIDITES

Muds in various shades of gray, greenish black (5GY 2/1), organic rich dark greenish gray (5GY 4/1), grading down to olive gray (5Y 4/1). Laminations indistinct with thin laminae of carbonates.

Varves are present in Section olive green and greenish gray couplets. Section 5 - 60 to 70 cm pyrite-rich.

Section 6 includes 2 to 5 cm thick cyclic deposition of dark gray (N3) mud to light gray micrite (N7), with sharp upper contact.

Organic-rich clay:
SS 1-100 cm
5% Quartz and Feldspar
90% Clay and Organic
4% Pyrite
< 1% Carb.

Sideritic mud:
SS 1-128 cm
2% Quartz and Feldspar
95% Clay and Dolomite
3% Pyrite, etc.

Mud:
SS 3-130 cm
15% Quartz and Feldspar
75% Clay
2% Pyrite
8% Carb. and Nannos

Seekreide:
SS 6-100 cm
[0, 80, 20]
10% Quartz and Feldspar
20% Clay
70% Calcite, silt-sized

X-ray:	Sec. 1 126-128	Sec. 3 124-126	Sec. 5 65-68	Sec. 6 78-80	96-98
Calcite	1%	14%	0%	27%	56%
Dolomite	4%	1%	0%	1%	0%
Quartz	7%	13%	16%	9%	5%
Feldspar	4%	4%	7%	3%	0%
Layered silicates	46%	66%	76%	59%	38%
Siderite	38%	0%	0%	0%	0%
Carb. bomb	5%	15%	0%	28%	56%

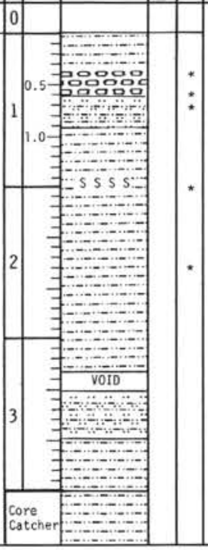
Grain Size:	Sec. 1 126-128	Sec. 3 114-126	Sec. 5 65-68	Sec. 6 78-80	96-98
Sand	1%	1%	0%	1%	1%
Silt	91%	95%	24%	59%	66%
Clay	8%	4%	76%	40%	33%

Carbonate:

	$CaCO_3$	Corg.
2-128 to 142	9%	0.4%
3-72 to 84	16%	0.6%
5-78 to 95	4%	0.3%

Site 380 Hole A Core 10 Cored Interval: 418.0-427.5 m

AGE	ZONE	FOSSIL CHARACTER POLLEN	FOSSIL CHARACTER NANNOS	FOSSIL CHARACTER OSTRACOD.	FOSSIL CHARACTER OTHERS	SECTION
		TS	—	—	A	Core Catcher



LITHOLOGIC DESCRIPTION

MUD, TURBIDITES, SEEKREIDE

Muds, in various shades of gray: olive gray, greenish gray, dark greenish gray. Darker layers are richer in pyrite, olive gray layers are lake marls, ~1 cm thick. Numerous sandy silt layers, but no more varves.

SS 1-41 cm (olive gray SEEKREIDE):
[0, 85, 15]
5% Quartz and Feldspar
15% Clay
80% Carbonate, silt-sized

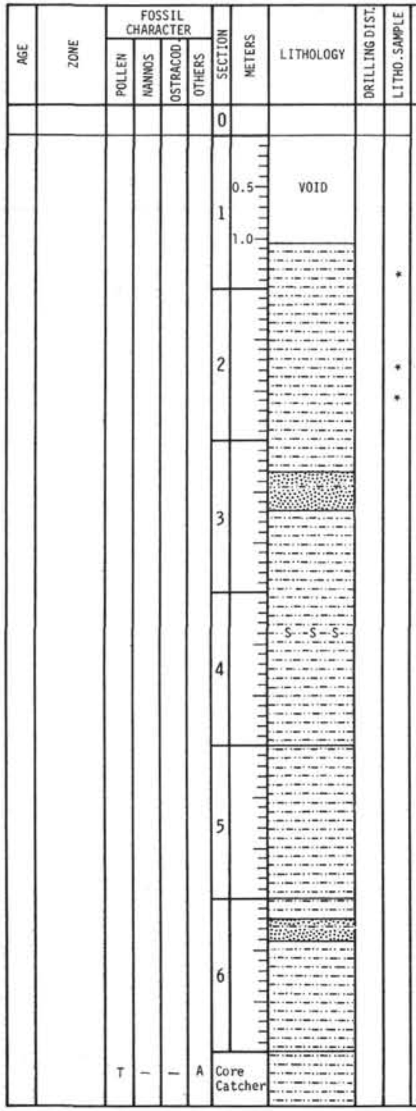
SS 1-52 cm (greenish gray mud):
20% Quartz and Felspar
30% Clay
50% Carbonate
Tr Pyrite

SS 1-55 cm (sandy silt):
[40, 40, 20]
50% Quartz and Feldspar
20% Clay
30% Carb.

SS 1-150 cm (SIDERITIC MUD):
7% Quartz and Feldspar
90% Clay and Siderite
3% Pyrite

Explanatory notes in Chapter 1

Site 380 Hole A Core 11 Cored Interval: 427.5-437.0 m



LITHOLOGIC DESCRIPTION

MUDS, TURBIDITES, SIDERITIC MUD

Muds, in various shades of gray: olive gray (5Y 6/1), olive gray (5Y 4/1), dark greenish gray (5G 4/1), and greenish black (5G 2/1) with silty turbidite layers.

Color changes indicate cyclically deposited layers 2 to 5 cm thick. One light olive gray SIDERITIC MUD.

DOMINANT LITHOLOGY:
SS 2-78 cm
[0, 50, 50]
25% Quartz and Feldspar
50% Clay, organic rich
10% Pyrite
15% Carb.

SS 2-98 cm:
20% Quartz and Feldspar
50% Clay
15% Pyrite
15% Carb.

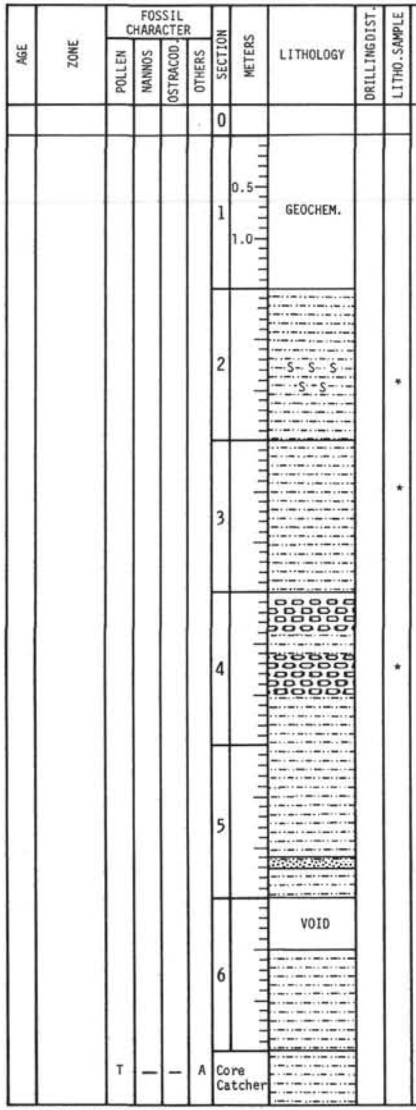
<u>X-ray</u>:

	2-46 to 48
Calcite	2%
Dolomite	0%
Quartz	20%
Feldspar	9%
Layered silicates	68%

<u>Grain Size</u>:

	2-46 to 48
Sand	2%
Silt	28%
Clay	70%

Site 380 Hole A Core 12 Cored Interval: 437.0-446.5 m



LITHOLOGIC DESCRIPTION

MUDS, SEEKREIDE, SIDERITE MUD, SANDY SILTS

Muds, dark greenish gray (5GY 4/1) with several intercalations of siderite and lake marls. The interval 2-130 to 145 cm shows cyclic sedimentation of mudsin different shades of gray. Section 4 includes 2 layers of greenish gray (5GY 6/1) SEEKREIDE. Intercalations of silty laminations are also present. Black pyrite-rich laminae are present.

DOMINANT LITHOLOGY (Mud):
SS 2-95 cm
10% Quartz and Feldspar
60% Clay
5% Pyrite
25% Carb.

MINOR LITHOLOGY (SEEKREIDE):
4-73 cm
[0, 90, 10]
8% Clay
90% Clacite in silt-size
2% Pyrite

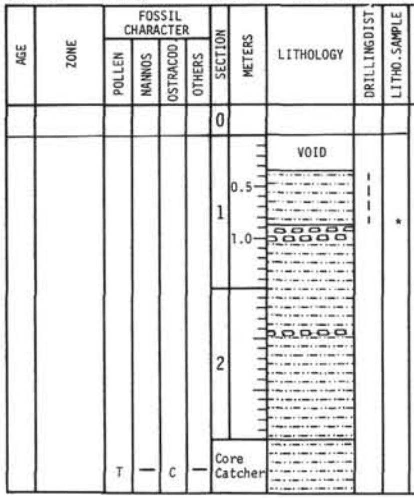
MINOR LITHOLOGY (Pyrite-rich mud):
SS 3-60 cm
[0, 40, 60]
15% Quartz and Feldspar
60% Clay
15% Pyrite
10% Carb.

<u>X-ray</u>:	Sec. 2		Sec. 4	
	15-23	68-70	28-30	86-88
Calcite	10%	1%	64%	66%
Dolomite	Tr	0%	0%	6%
Quartz	14%	3%	5%	4%
Feldspar	4%	0%	0%	0%
Layered silicates	72%	44%	30%	29%
Siderite	0%	52%	0%	0%
Carb. bomb	10%	1%	64%	66%

<u>Grain Size</u>:	Sec. 2	Sec. 4	
	15-23	28-30	86-88
Sand	1%	0%	1%
Silt	29%	66%	67%
Clay	70%	34%	32%

Explanatory notes in Chapter 1

Site 380 Hole A Core 13 Cored Interval: 446.5-456.0 m



LITHOLOGIC DESCRIPTION

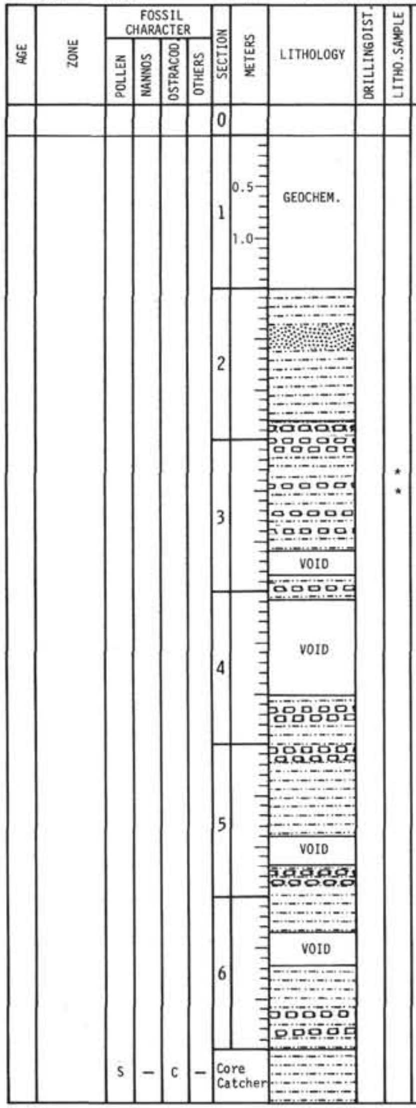
MUDS, SEEKREIDE

Muds same as Core 12.

Presence of SEEKREIDE, 100% calcite, very strong odor. Like camphor-ether.

We place the top of the seekreide formation at the Section 1-90 cm, at the top of this 100% calcite seekreide because this is the first downhole occurrence of a very pure seekreide.

Site 380 Hole A Core 14 Cored Interval: 456.0-465.5 m



LITHOLOGIC DESCRIPTION

SEEKREIDE ("MEGA-VARVES"), MUDS, SANDY SILTS

Section 3 is designated as the type-section of the "mega-varve" facies, which is almost identical to Core 50, Section 3. A typical cycle is 3 cm thick with medium gray (N5) mud at base, an intermediate zone of Chondrites burrows in the middle, and a light gray (N7) lake marl at the top. The upper contact with the next gray marl is typically sharp.

Contact with the gray mud facies is placed at Section 2, 140 cm. "Mega-varves" are indistinct where carb. ppt was moderate. Some intervals are mud facies as in Cores 12 and 13. Twenty-six cycles were counted in 1 m interval. Section 3, 0 to 100 cm varying from 0.5 to 8 cm thick.

SEEKREIDE:
SS 3-49 cm
10% Clay
90% Carb., silt-size
Tr Quartz and Feldspar, Mica, Pyrite

MARLY MUD:
SS 3-47 cm (in mega-varve):
10% Quartz and Feldspar
25% Clay
5% Pyrite, Opaque, etc.
60% Carb.

X-ray:

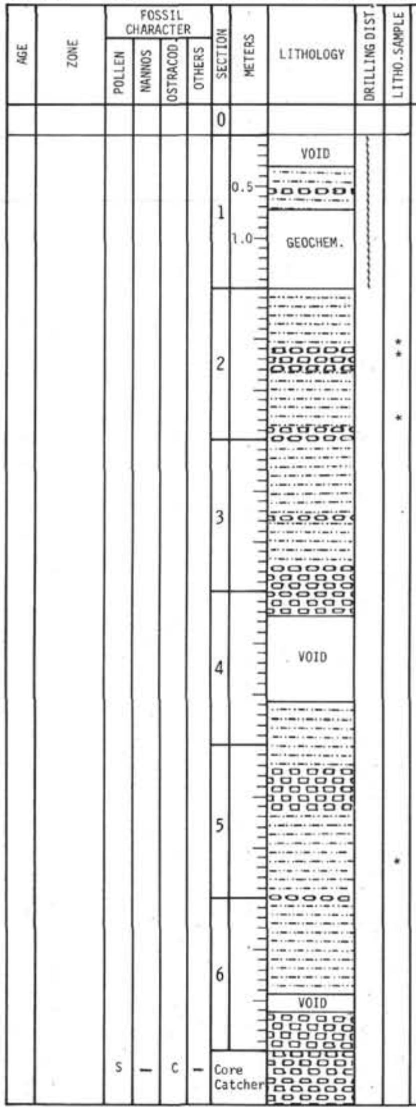
	2-23 to 25	3-2 to 14
Calcite	7%	43%
Dolomite	0%	2%
Quartz	22%	11%
Feldspar	6%	3%
Layered silicates	65%	40%
Carb. bomb	7%	45%

Grain Size:

	2-23 to 25	3-2 to 14
Sand	1%	0%
Silt	35%	53%
Clay	64%	47%

Explanatory notes in Chapter 1

Site 380 Hole A Core 15 Cored Interval: 465.5-475.0 m



LITHOLOGIC DESCRIPTION

SEEKREIDE, MUDS

SEEKREIDE, mixed with muds in intervals 10-50 cm thick. Indistinct "mega-varves" were recognized in a few intervals. Light gray marls (N7) and muds in various shades of gray with laminations, distinct or indistinct, are interbedded.

MARL:
SS 2-56 cm
15% Quartz and Feldspar
50% Clay
Tr Pyrite
35% Carb.

MUD:
SS 2-54 cm
20% Quartz and Feldspar
65% Clay
10% Pyrite
5% Carb.

PYRITE-RICH MUD, black:
SS 2-125 cm
Tr Quartz and Feldspar
65% Clay and Pyrite
35% Carb.

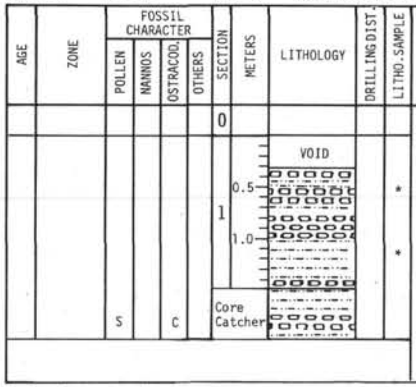
X-ray:

	2-117 to 119	CC
Calcite	34%	21%
Dolomite	1%	0%
Quartz	10%	15%
Feldspar	3%	5%
Layered silicates	51%	59%
Siderite	2%	0%

Grain Size:

	2-117 to 119
Sand	0%
Silt	52%
Clay	48%

Site 380 Hole A Core 16 Cored Interval: 475.0-484.5 m



LITHOLOGIC DESCRIPTION

SEEKREIDE, MARLS, MUDS

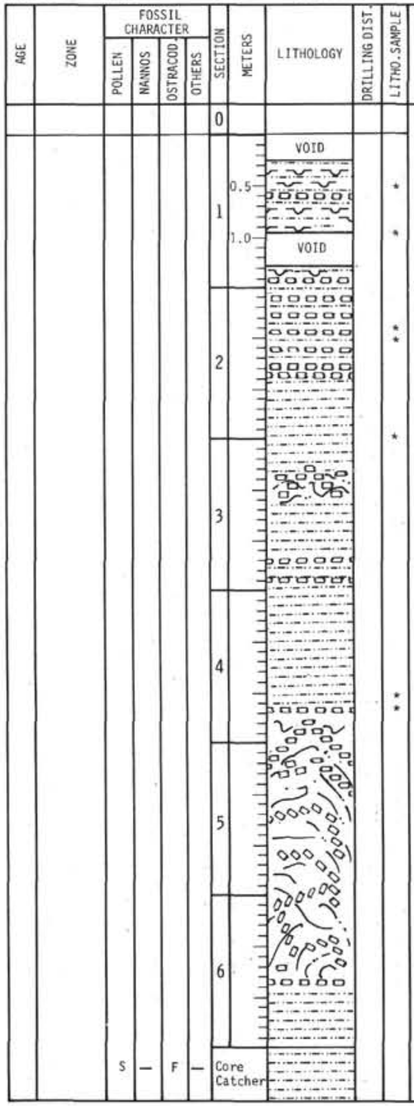
Marls, greenish gray (5GY 4/1), with laminae of organic-rich clay.

MARL:
SS 1-55 cm
20% Quartz and Feldspar
40% Clay
40% Carbonate, silt-sized

CLAY, ORGANIC RICH:
SS 1-115 cm
3% Quartz and Feldspar
90% Clay and Organic
7% Pyrite
Tr Carb.

Explanatory notes in Chapter 1

Site 380 Hole A Core 17 Cored Interval: 484.5-494.0 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS MARLS, SEEKREIDE, AND MUDS

Section 1 includes diatom rich section. Sections 2 to 6 are interbedded lake marls and dark greenish gray muds. Marls blocks in mud matrix are indicative of penecontemporaneous slumping. Bottom of section includes dark greenish gray and greenish black mud laminae, a few mm to a few cm thick.

DIATOMACEOUS MARL:
SS 1-89 cm
12% Quartz and Feldspar
20% Clay
3% Pyrite
40% Carb.
25% Diatoms

DIATOMACEOUS MUD:
SS 1-50 cm
10% Quartz and Feldspar
45% Clay
5% Pyrite
Tr Carb.
40% Diatoms

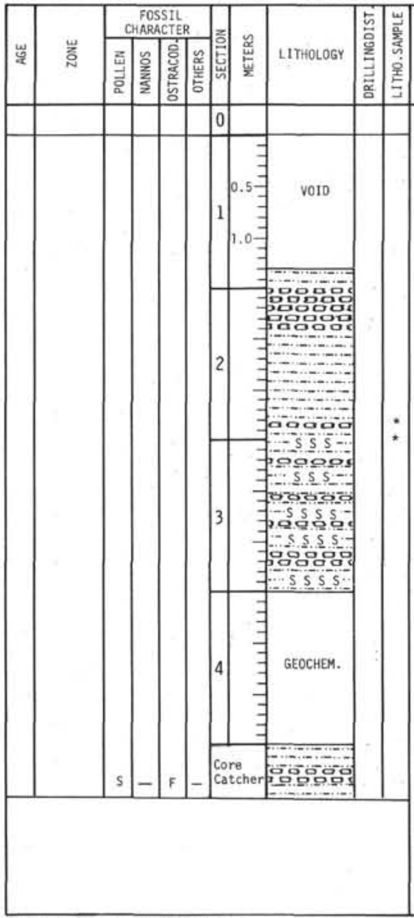
"SEEKREIDE":
SS 4-118 cm
Tr Quartz and Feldspar
5% Clay
Tr Pyrite
95% Carb., silt-sized

MUD:
SS 4-114 cm
15% Quartz and Feldspar
45% Clay
10% Pyrite
30% Carb.

X-ray:	Sec. 1		Sec. 3
	70-72	89-91	105-107
Calcite	4%	40%	57%
Dolomite	2%	2%	0%
Quartz	20%	10%	5%
Feldspar	8%	4%	0%
Layered silicates	65%	43%	37%
Carb. bomb	6%	42%	57%

Grain Size:	Sec. 1		Sec. 3
	70-72	89-91	105-107
Sand	1%	0%	0%
Silt	58%	70%	65%
Clay	41%	30%	35%

Site 380 Hole A Core 18 Cored Interval: 494.0-503.5 m



LITHOLOGIC DESCRIPTION

MUDS, SEEKREIDE, MARLS

Muds and marls various shades of greenish gray, mainly dark greenish gray (5GY 4/1) with intercalations of greenish gray and almost pure dolomite.

Section 3 includes alternation of SEEKREIDE (or SIDERITIC SEEKREIDE) and marl. Cycles are a few centimeters thick.

MUD:
SS 2-127 cm
10% Quartz and Feldspar
80% Clay
5% Pyrite
5% Carb.

SIDERITE MUD:
SS 2-147 cm
Tr Quartz and Feldspar
5% Clay
Tr Pyrite
95% Siderite

SEEKREIDE:
SS 3-60 cm
Tr Quartz and Feldspar and Pyrite
5% Clay
95% Siderite

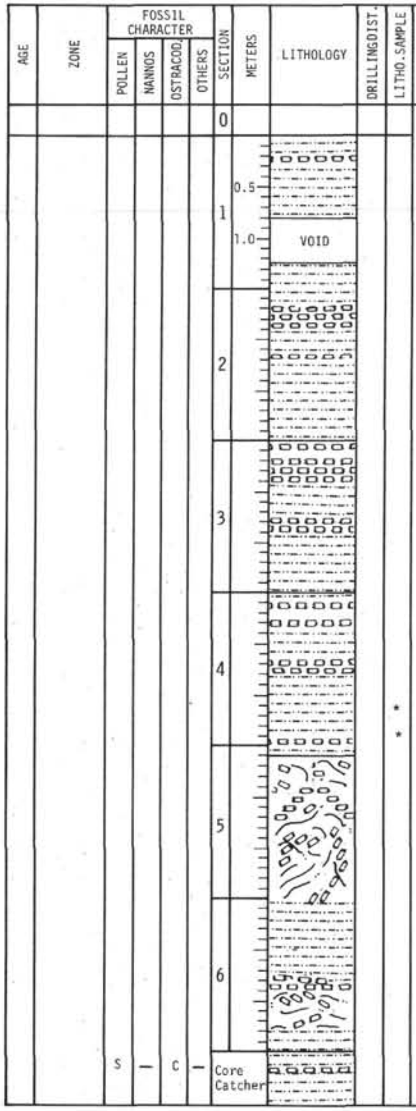
MARL:
SS 3-57 cm
10% Quartz and Feldspar
50% Clay
40% Siderite

X-ray:	Sec. 2		Sec. 3
	75-77	102-104	61-63
Calcite	3%	35%	57%
Dolomite	0%	0%	0%
Quartz	19%	9%	4%
Feldspar	7%	3%	2%
Layered silicates	71%	53%	31%
Siderite	0%	0%	6%

Grain Size:	Sec. 2	
	75-77	102-104
Sand	2%	0%
Silt	28%	54%
Clay	70%	46%

Explanatory notes in Chapter 1

Site 380 Hole A Core 19 Cored Interval: 503.5-513.0 m



LITHOLOGIC DESCRIPTION

SEEKREIDE, MARLS, AND MUDS

Interbedded seekreide, marls and muds.

Light olive gray seekreide and greenish gray marl lamination constitute cycles a few centimeters thick. Intervals of muds almost devoid of carbonates, which are bluish gray (5B 5/1) and dark greenish gray (5G 4/1). Seekreide and marl in slump block.

MARL:
SS 4-110 cm
5% Quartz and Feldspar
45% Clay
10% Pyrite
40% Carb. silt-sized

SEEKREIDE
SS 4-141 cm
Tr Quartz and Feldspar
10% Clay
Tr Pyrite
90% Carb., Sideritic in part, silt-sized

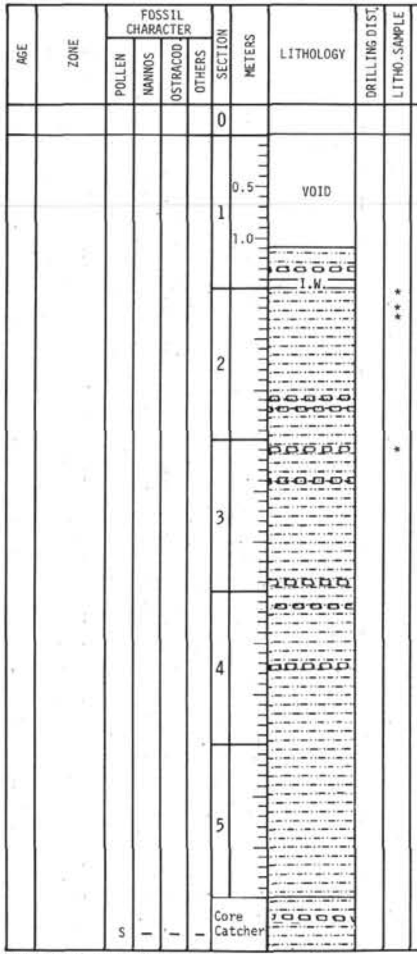
<u>X-ray</u>:

	4-139 to 140
Calcite	56%
Dolomite	0%
Quartz	5%
Feldspar	0%
Layered silicates	38%
Carb. bomb	56%

<u>Grain Size</u>:

	4-139 to 140
Sand	0%
Silt	63%
Clay	37%

Site 380 Hole A Core 20 Cored Interval: 513.0-522.5 m



LITHOLOGIC DESCRIPTION

SEEKREIDE AND MUDS

Alternation in 2 to 5 cm thick cyclic bedding of light olive gray (5Y 6/1) and greenish gray (5GY 6/1) marls with muds in various shades of gray. Burrowing (<u>Chondrites</u>) evident in both light and dark greenish gray SEEKREIDE.

Dark gray mud:
SS 2-19 cm
10% Quartz and Feldspar
50% Clay
20% Pyrite
20% Carb.

Greenish gray seekreide:
SS 2-27 cm
10% Quartz and Feldspar
40% Clay
Tr Pyrite
50% Carb.

Light olive gray seekreide
SS 3-10 cm
5% Quartz and Feldspar
40% Clay
55% Carb., silt-sized

<u>X-ray</u>:

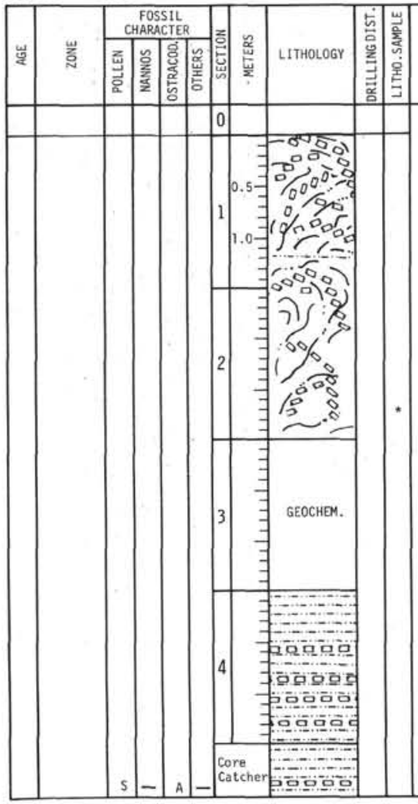
	2-96 to 98	5-44 to 46
Calcite	56%	0%
Dolomite	0%	0%
Quartz	5%	19%
Feldspar	0%	7%
Layered silicates	38%	74%
Carb. bomb	56%	0%

<u>Grain Size</u>:

	2-96 to 98	5-44 to 46
Sand	0%	0%
Silt	57%	24%
Clay	43%	76%

Explanatory notes in Chapter 1

Site 380 Hole A Core 21 Cored Interval: 522.5-532.0 m



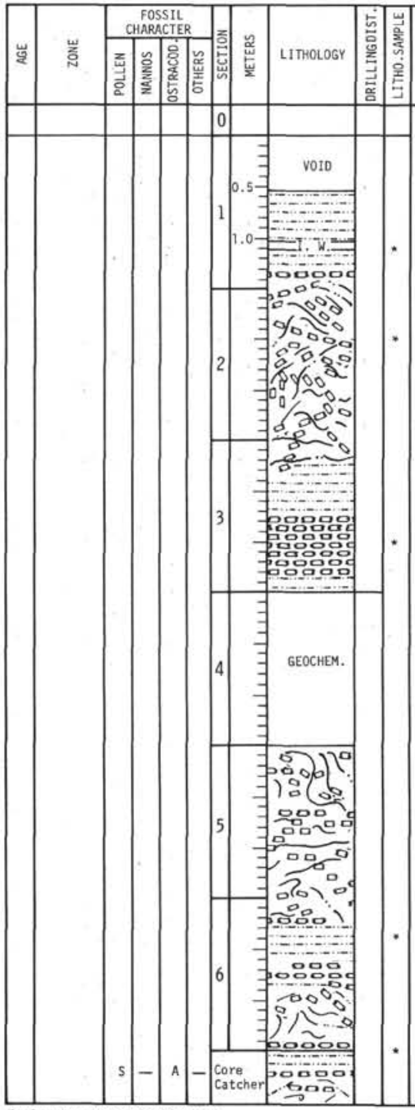
LITHOLOGIC DESCRIPTION

SEEKREIDE, MARLS, AND MUDS

Slump block of interbedded light olive gray seekreide; and greenish gray to greenish black marls and muds.

Marl:
SS 1-124 cm
5% Quartz and Feldspar
35% Clay
Tr Pyrite
60% Carb.

Site 380 Hole A Core 22 Cored Interval: 532.0-541.5 m



LITHOLOGIC DESCRIPTION

SEEKREIDE, MARLS, AND MUDS

Interbedded sequence of seekreide, greenish gray (5GY 6/1); marls, light olive gray (5Y 6/1) and greenish gray (5G 6/1); and muds, dark greenish gray (5GY /1).

Two slump intervals. A few silty intercalations.

Seekreide:
SS 6-145
10% Quartz and Feldspar
10% Clay
80% Carb., silt-sized, some rhombs

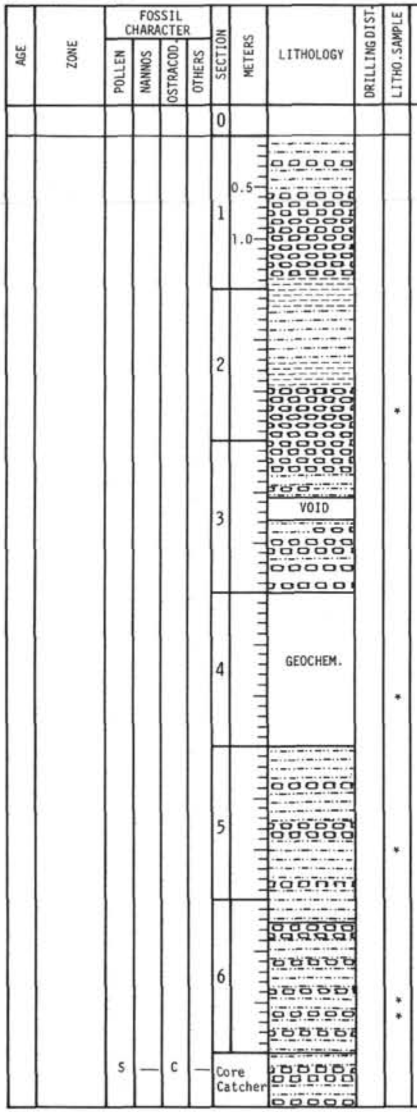
Mud:
SS 1-118
15% Quartz and Feldspar
75% Clay
5% Pyrite
5% Carb.

X-ray:	Sec. 6 40-42	53-55	68-70	80-82
Calcite	36%	35%	66%	65%
Dolomite	0%	0%	0%	0%
Quartz	9%	8%	4%	4%
Feldspar	3%	4%	0%	0%
Layered silicates	52%	52%	29%	30%
Carb. bomb	36%	35%	66%	65%

Grain Size:	Sec. 6 40-42	53-55	68-70	80-82
Sand	1%	0%	0%	1%
Silt	46%	52%	68%	73%
Clay	53%	48%	32%	26%

Explanatory notes in Chapter 1

Site 380 Hole A Core 23 Cored Interval: 541.5-551.0 m



LITHOLOGIC DESCRIPTION

SEEKREIDE, LAMINATED CLAYS, MARLS, AND MUDS

Seekreide, light olive gray (5Y 6/1) to greenish gray (5GY 6/1) interbedded with laminated clays, or marls and mud. Varve-like 2 to 5 mm laminae. Clay, pyrite-rich black. Mud, greenish gray (5G 4/1). Marl, greenish gray (5G 4/1). Particularly in Section 2, 65 to 100 cm interval.

Seekreide:
SS 2-72 cm
15% Quartz and Feldspar
10% Clay
75% Carb.

Marl:
SS 5-96 cm
5% Quartz and Feldspar
30% Clay
5% Pyrite
60% Carb.

Section 6 below 22 cm, the seekreide and marls from "mega-varves", with typical upper contact sharp. Greenish gray seekreide grades down into burrowed (Chondrites) zone, and into greenish gray marl, and carb. content decreases from 90% to 60%.

X-ray:

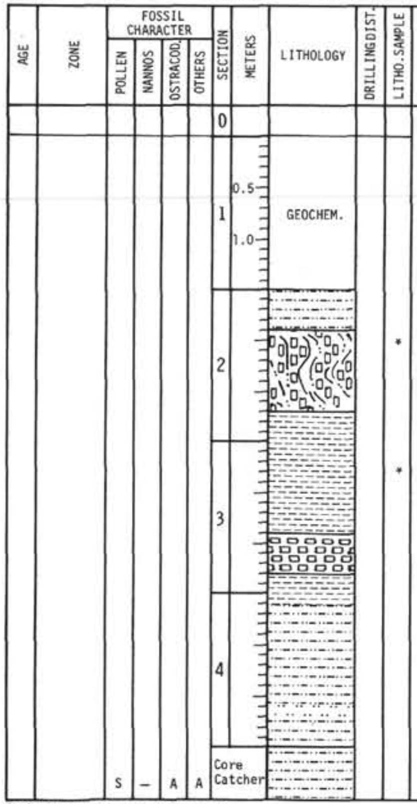
	1-40 to 42
Calcite	15%
Dolomite	0%
Quartz	13%
Feldspar	5%
Layered silicates	67%
Carb. bomb	15%

Grain Size:

	1-40 to 42
Sand	0%
Silt	32%
Clay	68%

Site 380A, Core 24, 551.0-560.5 m: NO RECOVERY

Site 380 Hole A Core 25 Cored Interval: 560.5-570.0 m



LITHOLOGIC DESCRIPTION

MUDS, LAMINATED ORGANIC-RICH CLAYS AND MUDS AND SEEKREIDE

Section 1, 40 to 120 cm interval, slump block of laminated seekreide and black mud.

Organic-rich clay:
SS 2-37 cm
>5% Quartz and Feldspar
80% Clay, organic-rich
10% Pyrite
3% Carb.

Seekreide:
SS 2-45 cm
10% Quartz and Feldspar
10% Clay
5% Pyrite
75% Carb., silt-sized

Organic-rich mud:
SS 2-46 cm
10% Quartz and Feldspar
55% Clay, organic-rich
10% Pyrite
25% Carb.

X-ray:

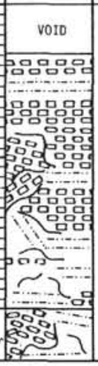
	2-123 to 125
Calcite	4%
Dolomite	1%
Quartz	15%
Feldspar	3%
Layered silicates	75%
Pyrite	1%
Carb. bomb	5%

Grain Size:

	2-123 to 125
Sand	0%
Silt	63%
Clay	37%

Explanatory notes in Chapter 1

Site 380 Hole A Core 26 Cored Interval: 570.0-579.5 m



AGE	ZONE	FOSSIL CHARACTER POLLEN	NANNOS	OSTRACOD.	OTHERS	SECTION	METERS	LITHOLOGY	DRILLING DIST.	LITHO. SAMPLE
						0				
						1	0.5 1.0	VOID		* *
						2				
		S	—	A	—	Core Catcher				

LITHOLOGIC DESCRIPTION

SEEKREIDE AND MARLS

Seekreide light olive gray (5Y 6/1), marl gray (5Y 5/1), from cyclic layering, also known as "mega-varves". The sediments are in a slump mass.

Seekreide:
SS 1-110 cm
9% Quartz and Feldspar
10% Clay
1% Pyrite
80% Carb., silt-sized

Marl:
SS 1-134 cm
13% Quartz and Feldspar
50% Clay
2% Pyrite
35% Carb.

Site 380 Hole A Core 27 Cored Interval: 579.5-589.0 m

AGE	ZONE	FOSSIL CHARACTER POLLEN	NANNOS	OSTRACOD.	OTHERS	SECTION	METERS	LITHOLOGY	DRILLING DIST.	LITHO. SAMPLE
						0				
						1	0.5 1.0	VOID		
						2		GEOCHEM.		
						3				
						4				
						5				
						6				
		TS	—	—	C	Core Catcher				

LITHOLOGIC DESCRIPTION

MARL, CLAY, AND SEEKREIDE

Mainly in a slump mass.

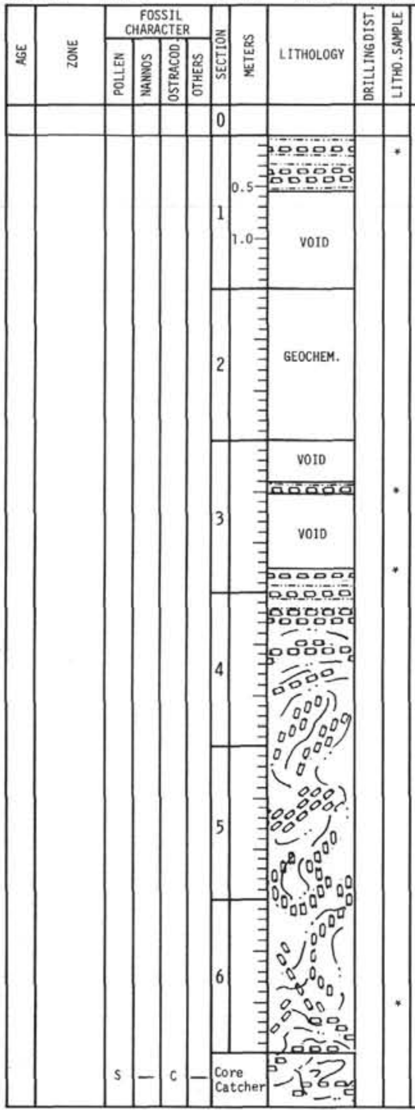
Clay:
SS 3-24 cm
5% Quartz and Feldspar
85% Clay
5% Pyrite
5% Carb.

Seekreide:
SS 3-35 cm
15% Quartz and Feldspar
10% Clay
Tr Pyrite
75% Carb.

Site 380A, Core 28, 589.0-593.0 m: NO RECOVERY

Explanatory notes in Chapter 1

Site 380 Hole A Core 29 Cored Interval: 593.0-598.5 m



LITHOLOGIC DESCRIPTION

SEEKREIDE, MARLS AND MUDS

Mainly seekreide in slump facies.

Seekreide:
SS 3-145 cm
10% Quartz and Feldspar
15% Clay
Tr Pyrite and Mica
75% Carb.

Mud:
SS 1-9 cm
10% Quartz and Feldspar
75% Clay
10% Pyrite
5% Carb.

Seekreide:
SS 6-100 cm
8% Quartz and Feldspar
10% Clay
2% Pyrite
80% Carb.

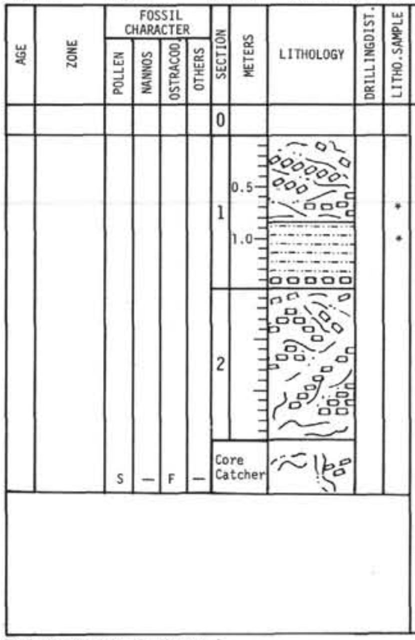
X-ray:

	6-131 to 133
Calcite	41%
Dolomite	Tr
Quartz	7%
Feldspar	3%
Layered silicates	49%
Carb. bomb	41%

Grain Size:

	6-131 to 133
Sand	1%
Silt	55%
Clay	44%

Site 380 Hole A Core 30 Cored Interval: 598.5-608.0 m



LITHOLOGIC DESCRIPTION

SEEKREIDE, MARLS, MUDS

Seekreide and marls in slump facies with interbedded muds.

Mud:
SS 1-80 cm
10% Quartz and Feldspar
80% Clay
10% Pyrite
Tr Carb.

Silt:
SS 1-100 cm
65% Quartz and Feldspar
10% Pyrite, Mica, etc.
10% Clay
15% Carb.

X-ray:

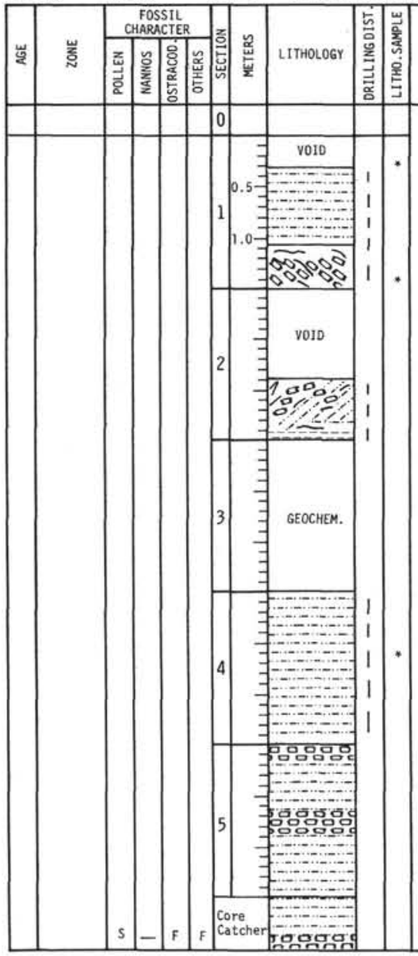
	1-105 to 108	2-56 to 58
Calcite	Tr	56%
Dolomite	2%	0%
Quartz	17%	4%
Feldspar	9%	2%
Layered silicates	72%	37%
Carb. bomb	2%	56%

Grain Size:

	1-105 to 108	2-56 to 58
Sand	1%	0%
Silt	33%	74%
Clay	66%	26%

Explanatory notes in Chapter 1

Site 380 Hole A Core 31 Cored Interval: 608.0-617.5 m



LITHOLOGIC DESCRIPTION

MUDS, SEEKREIDE, CLAYS

Seekreide, creamy white, in < 1 mm laminae separated by greenish gray marl in < 1 mm laminae. (Annual varves?). Where laminations are obscure, the seekreide is light olive gray (5Y 6/1).

Muds and clays are present as interbeds.

Marl:
SS 1-145 cm
10% Quartz and Feldspar
30% Clays
Tr Pyrite
60% Carb.

Mud:
SS 1-30 cm
13% Quartz and Feldspar
80% Clay
5% Pyrite
2% Carb.

Seekreide:
SS 4-56 cm
< 10% Quartz and Feldspar
5% Clay
1% Pyrite
85% Carb.

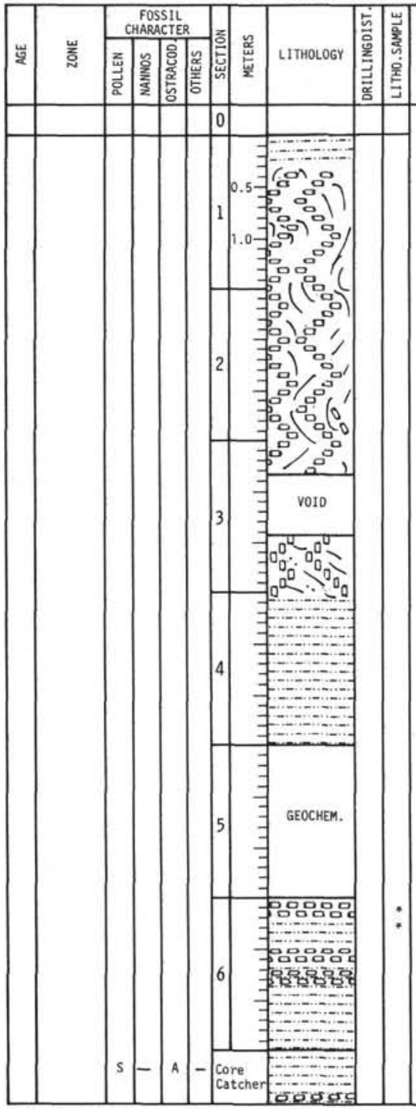
X-ray:

	1-81 to 82
Calcite	1%
Dolomite	0%
Quartz	16%
Feldspar	7%
Layered silicates	76%
Carb. bomb	1%

Grain Size:

	1-81 to 82
Sand	1%
Silt	29%
Clay	70%

Site 380 Hole A Core 32 Cored Interval: 617.5-627.0 m



LITHOLOGIC DESCRIPTION

SEEKREIDE, MARLS, MUDS

Seekreide and finely laminated, mm-thin lamination of almost pure calcite with organic-rich marls in Cores 1 and 3. Slump folds have been recognized by tracing the reversal of facing of the laminations. However, sand rotation of seekreide pieces in Section 6 might be the result of drilling disturbance. Marl, homogeneous in Section 4. Mud, medium dark green bottom of Section 6.

Seekreide:
SS 6-15 cm
10% Quartz and Feldspar
15% Clay
Tr Pyrite
75% Carb.

Marl:
SS 4-100 cm
10% Quartz and Feldspar
50% Clay
Tr Pyrite
40% Carb.

X-ray:

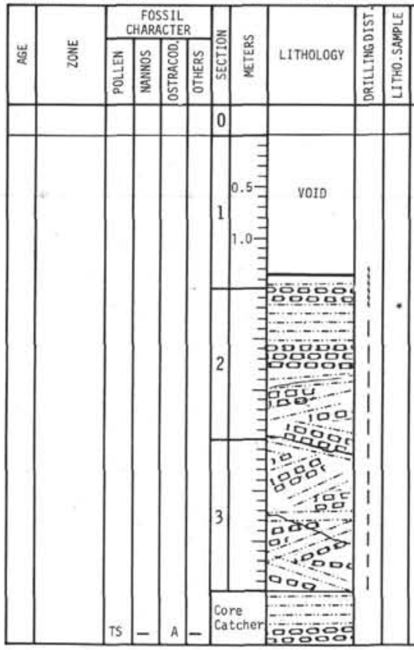
	1-5 to 7
Calcite	0%
Dolomite	0%
Quartz	13%
Feldspar	7%
Layered silicates	80%
Carb. bomb	0%

Grain Size:

	1- 5 to 7
Sand	0%
Silt	39%
Clay	61%

Explanatory notes in Chapter 1

Site 380 Hole A Core 33 Cored Interval: 631.0-636.5 m



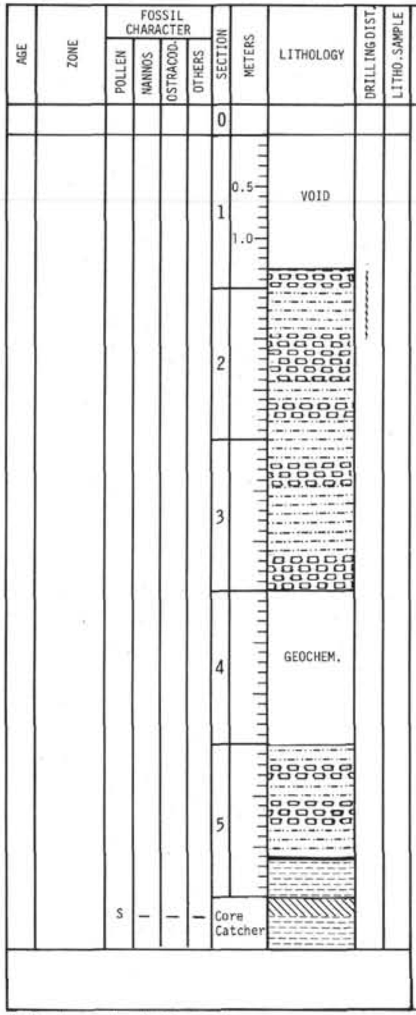
LITHOLOGIC DESCRIPTION

SEEKREIDE, MARLS, MUDS

Seekreide and marls, muds inclined more than 5° bedding probably a slump mass in pyrite-rich streaks.

MINOR LITHOLOGY:
SS 2-27 cm
3% Quartz and Feldspar
5% Clay
90% Pyrite
2% Carb.

Site 380 Hole A Core 34 Cored Interval: 636.5-646.0 m



LITHOLOGIC DESCRIPTION

MARLS, SEEKREIDE, CLAYS, SIDERITE

Seekreide, finely laminated, with mm-thin organic-rich and carb.-rich laminae. This laminated seekreide is interbedded with marls in 2-3 cm cycles. This whole sequence has inclined bedding, probably caused by penecontemporaneous slumping, although the dips may have been accentuated by drilling disturbance.

Seekreide, light olive gray (5Y 6/1) marl, olive gray (5Y 4/1). Chondrite burrows are common. The sediment gives off strong odor of hydrocarbon and is comparable to "oil shale".

The base of seekreide formation is marked in Section 5, 110 cm, where it is underlain by a clay and mud formation.

Marl:
SS 5-105 cm
[0, 36, 65]
20% Quartz and Feldspar
45% Clay
Tr Pyrite
35% Carb., both clay and silt-sized

Clay:
SS 5-128 cm
[0, 10, 90]
5% Quartz and Feldspar
90% Clay
5% Pyrite
Tr Carb.

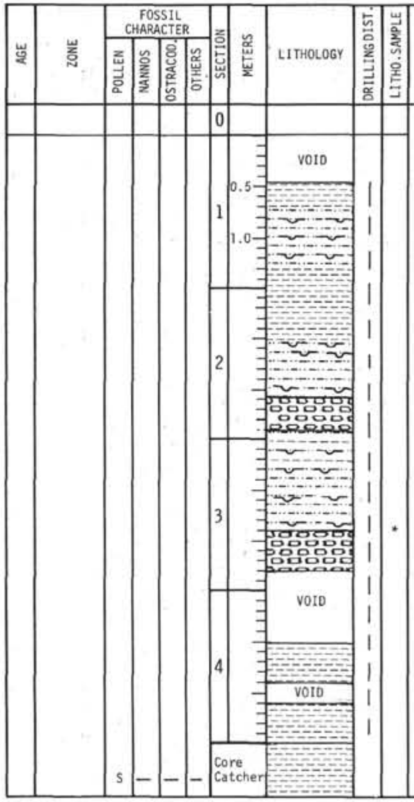
Siderite layer present in the core catcher.

X-ray:	Sec. 3 84-86	Sec. 4 52-55	Sec. 5 145-147	CC
Calcite	30%	20%	0%	2%
Dolomite	0%	0%	0%	1%
Quartz	7%	10%	16%	4%
Feldspar	3%	3%	3%	0%
Layered silicates	60%	63%	81%	31%
Pyrite	0%	3%	0%	0%
Siderite	0%	0%	0%	62%
Carb. bomb	30%	20%	0%	3%

Grain Size:	Sec. 5 145-147
Sand	0%
Silt	27%
Clay	73%

Explanatory notes in Chapter 1

Site 380 Hole A Core 35 Cored Interval: 646.0-655.5 m



LITHOLOGIC DESCRIPTION

ORGANIC-RICH CLAY, SEEKREIDE DIATOMACEOUS CLAY

Organic-rich clay, olive gray (5Y 3/2) diatom-bearing.

Three intercalations of Seekreide, light olive gray (5Y 5/2) to olive gray, interlaminated, with marl or mud.

DOMINANT LITHOLOGY:
SS 3-92 cm
3% Quartz and Feldspar
90% Clay
2% Pyrite
5% Diatom

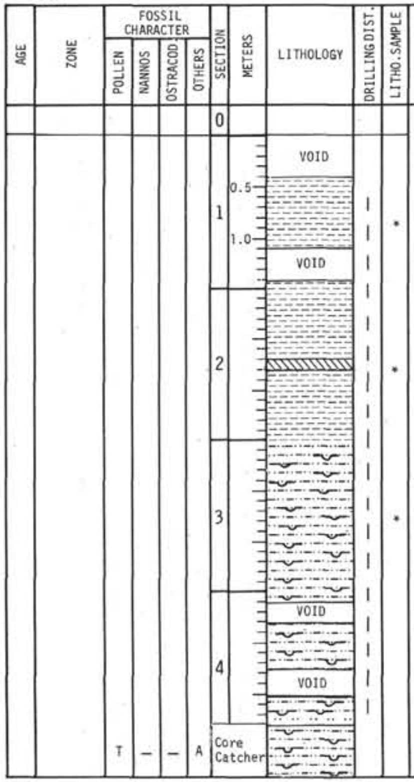
X-ray:

	4-86 to 87
Calcite	1%
Dolomite	0%
Quartz	13%
Feldspar	4%
Layered silicates	82%
Carb. bomb	1%

Grain Size:

	4-86 to 87
Sand	0%
Silt	23%
Clay	77%

Site 380 Hole A Core 36 Cored Interval: 655.5-665.0 m



LITHOLOGIC DESCRIPTION

CLAYS, ORGANIC-RICH SIDERITE

Organic-rich clays, mainly olive gray (5Y 3/2), Section 2 some very dark gray (5Y 3/1), some diatom-bearing.

A block of firm monomineralic sediment, siderite, at Section 2 (90 to 100 cm), in wheat-shaped grains, with trace of pyrite.

The sediment fractured by drilling.

DOMINANT LITHOLOGY:
SS 1-90 cm
5% Quartz and Feldspar
95% Clay
Tr Pyrite and Mica

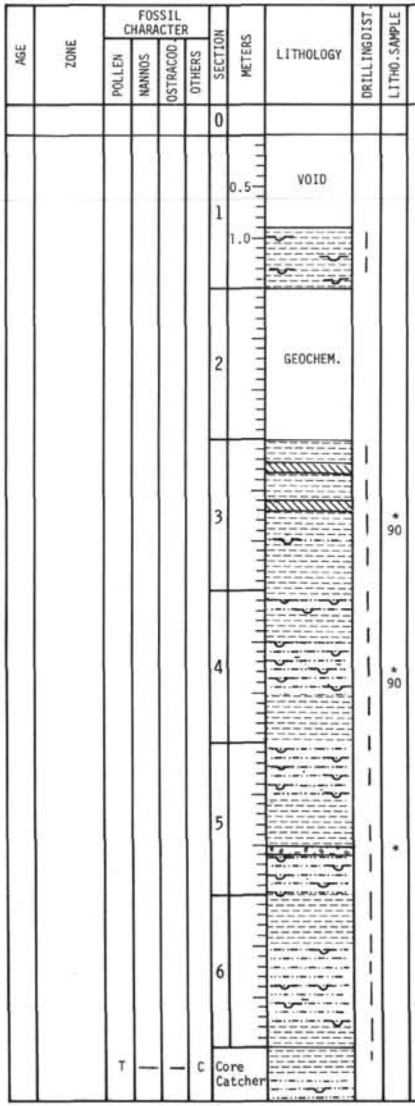
SS 3-80 cm
< 5% Quartz and Feldspar
90% Clay
2% Pyrite
Tr Carb.
< 5% Diatom

X-ray:

	2-80 to 82
Layered silicates	41%
Siderite	59%

Explanatory notes in Chapter 1

Site 380 Hole A Core 37 Cored Interval: 665.0-674.5 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS CLAYS, CLAYS, SIDERITE

Diatom-rich clay, olive gray (5Y 3/2) clay, medium dark gray (N4).

Siderite, pale olive (5Y 6/4).

Clay:
SS 3-90 cm
5% Quartz and Feldspar
95% Clays
Tr Pyrite

Diatom-rich clay:
SS 4-90 cm
5% Quartz and Feldspar
80% Clays
Tr Pyrite
15% Diatoms

Section 5, 103 cm:
Dacitic tuff, white-colored, glass shards, idiomorphic quartz, dark minerals (biotite).

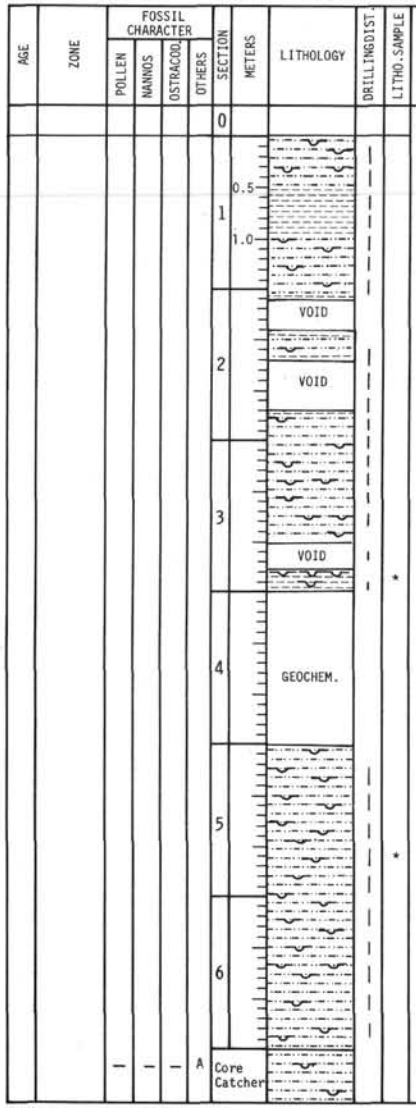
X-ray:

	3-81 to 83	6-134 to 136
Calcite	0%	0%
Dolomite	0%	1%
Quartz	15%	4%
Feldspar	9%	0%
Layered silicates	76%	30%
Siderite	0%	66%
Carb. bomb	0%	1%

Grain Size:

	3-81 to 83
Sand	0%
Silt	16%
Clay	84%

Site 380 Hole A Core 38 Cored Interval: 674.5-684.0 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS CLAYS, CLAYS

Diatomaceous clays, olive gray (5Y 3/2, 5Y 4/1) laminated in part, lamination mm to cm in thickness.

Clay, medium dark gray (N4).

Diatom-rich clay:
SS 5-100 cm
5% Quartz and Feldspar
75% Clay
5% Pyrite
15% Diatoms

Diatomaceous clay:
SS 3-138 cm
5% Quartz and Feldspar
50% Clay
5% Pyrite
40% Diatoms

Pyrite-rich clay:
SS 1-75 cm
5% Quartz and Feldspar
85% Clay
10% Pyrite

X-ray:

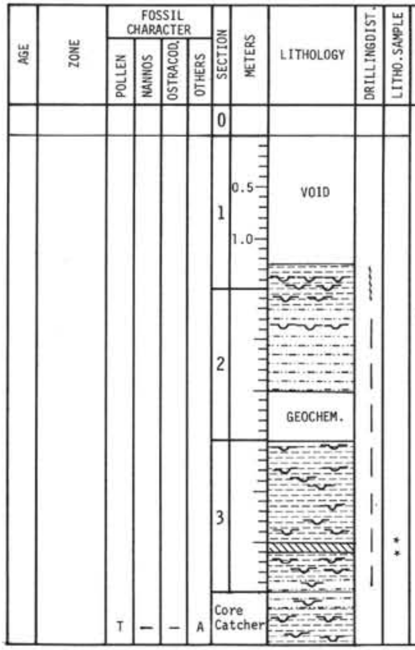
	3-89 to 91	6-77 to 79
Calcite	0%	0%
Dolomite	Tr	0%
Quartz	14%	12%
Feldspar	5%	5%
Layered silicates	81%	83%
Carb. bomb	0%	0%

Grain Size:

	3-89 to 91	6-77 to 79
Sand	0%	0%
Silt	15%	25%
Clay	85%	75%

Explanatory notes in Chapter 1

Site 380 Hole A Core 39 Cored Interval: 684.0-693.5 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS CLAYS, SIDERITE

Diatom-rich clay, olive gray (5Y 3/2) mm laminae in various shades of olive gray related to varying abundance of diatoms. Little difference in lithology between laminated clays and thicker laminae (>1 cm) siderite intercalation.

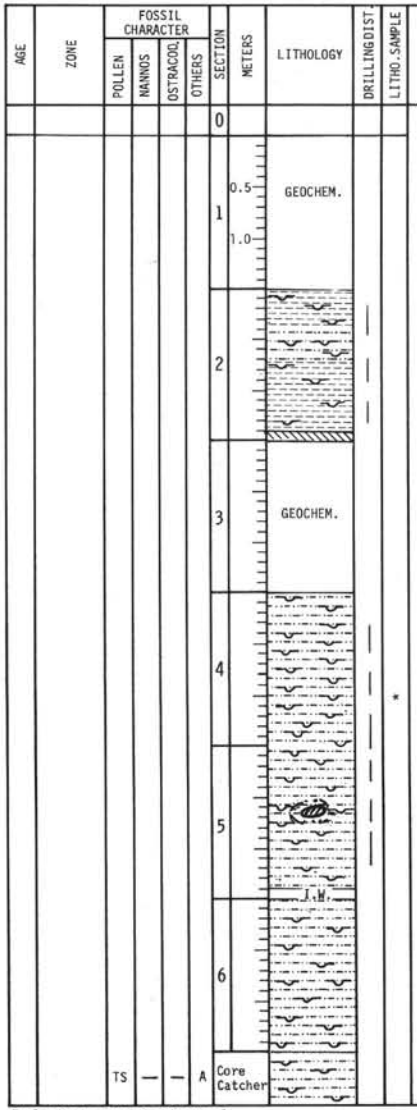
Olive gray lamina:
SS 3-102 cm
5% Quartz and Feldspar
30% Clay
5% Pyrite
60% Diatoms
Tr Carb.

Thicker lamina:
SS 3-102 cm
<5% Quartz and Feldspar and Carb.
35% Clay
60% Diatoms

X-ray:

	3-102 to 104
Calcite	0%
Dolomite	0%
Quartz	6%
Feldspar	0%
Layered silicates	45%
Siderite	49%
Carb. bomb	0%

Site 380 Hole A Core 40 Cored Interval: 693.5-703.0 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS CLAYS, CLAYS

Diatom-rich clays, in part laminated with mm-thick laminations in various shades of olive gray (5Y 3/2).

Siderite intercalation and nodule (hard).

Diatom-bearing clay:
SS 4-96 cm
Tr Quartz and Feldspar
95% Clay
Tr Pyrite and Carb.
5% Diatoms

X-ray:

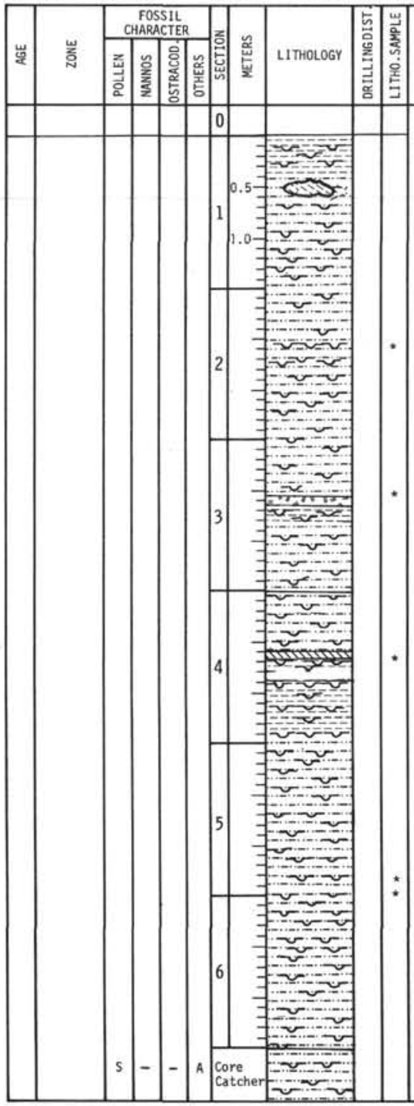
	5-60 to 63	6-20 to 22
Calcite	0%	0%
Dolomite	0%	0%
Quartz	2%	10%
Feldspar	0%	4%
Layered silicates	32%	84%
Siderite	66%	0%

Grain Size:

	6-20 to 22
Sand	1%
Silt	30%
Clay	70%

Explanatory notes in Chapter 1

Site 380 Hole A Core 41 Cored Interval: 703.0-712.5 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS CLAYS, DIATOM OOZES, SIDERITE

Diatomaceous clays and clayey diatom oozes, in places, very distinct laminations, mm-thin of lighter diatom-rich and darker clay-richer laminae, in shades of olive gray (5Y 3/2), varve-like annual(?) layers.

Clayey diatom ooze:
SS 5-141.5 cm
Tr Quartz and Feldspar
20% Clay
80% Diatoms
Tr Pyrite

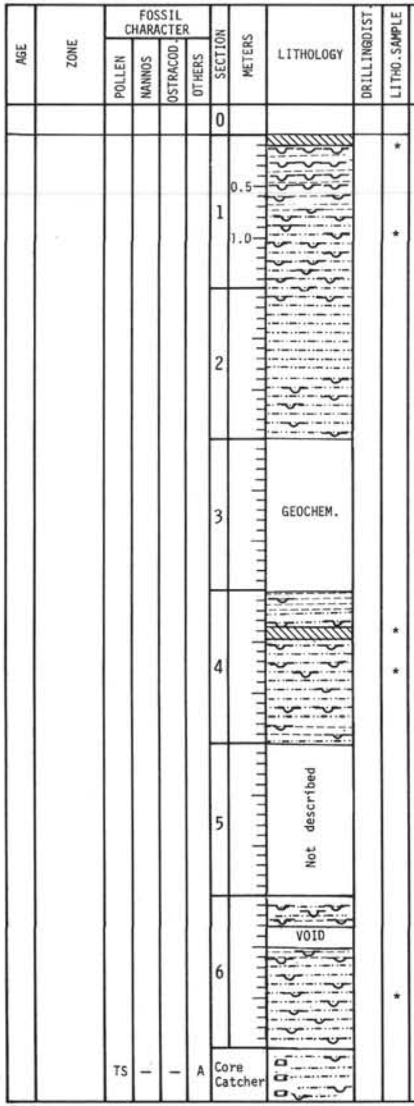
Diatom-rich clay:
SS 5-141 cm
Tr Quartz and Feldspar
85% Clay
Tr Pyrite
15% Diatoms

Dacitic tuff
SS 3-55 cm

X-ray:	3-54 to 55
Calcite	0%
Dolomite	0%
Quartz	7%
Feldspar	2%
Layered silicates	87%

Grain Size:	3-54 to 55
Sand	3%
Silt	71%
Clay	26%

Site 380 Hole A Core 42 Cored Interval: 712.5-722.0 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS CLAYS, DIATOMACEOUS OOZES, SIDERITIC CLAYS, SIDERITE

Diatom-rich clays (~30% diatoms) dark greenish gray mainly well laminated diatom oozes and clays (Section 1).

Sideritic diatomaceous clays are present in Sections 5 and 6, and are laminated (mm thin laminae) in colors light and dark gray brown (2.5Y 5/2 - 4/2).

Siderite laminations.

DOMINANT LITHOLOGY:
65% Clay
5% Pyrite
30% Diatoms

Clayey siderite:
SS 4-61 cm
Tr Quartz and Feldspar
20% Clay
70% Siderite
10% Diatoms
Tr Pyrite

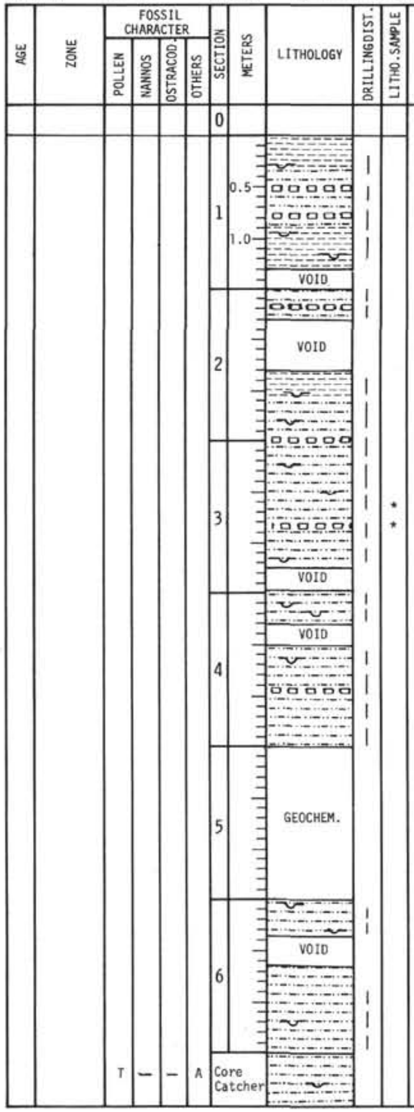
Siderite:
SS 1-5 cm
< 5% Clay
95% Siderite
Tr Pyrite

X-ray:	Sec. 1 2-3	Sec. 4 40-42	Sec. 5 82-84	CC
Calcite	0%	7%	0%	28%
Dolomite	0%	0%	0%	0%
Quartz	7%	6%	9%	8%
Feldspar	2%	0%	2%	2%
Layered silicates	87%	47%	87%	59%
Pyrite	2%	0%	0%	0%
Siderite	0%	40%	0%	0%

Grain Size:	Sec. 1 2-3	Sec. 5 82-84
Sand	1%	0%
Silt	56%	44%
Clay	43%	56%

Explanatory notes in Chapter 1

Site 380 Hole A Core 43 Cored Interval: 722.0-731.5 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS CLAYS AND MARLS

Laminae of dark olive gray (5Y 3/2) clay, light olive gray (5Y 6/1) marl. Laminae are sharply defined, and range from 1 mm to a few cm in thickness.

Carbonate is clay-size, but calcitic, and is varying in amount. Diatoms are also varying in abundance, but are less common as in Cores 41 and 42.

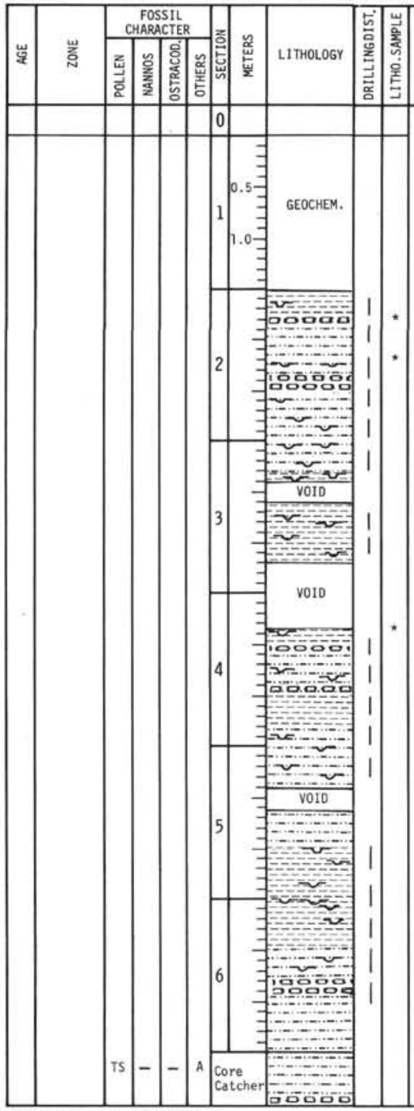
Clay:
SS 2-81 cm
5% Quartz and Feldspar
90% Clay
2% Pyrite
Tr Carb.
3% Diatoms

Marl:
SS 2-80 cm
10% Quartz and Feldspar
Tr Mica and Pyrite
50% Clay
30% Carb., clay-sized, calcitic
10% Diatoms

X-ray:	Sec. 1 32-34	Sec. 2 101-102	Sec. 4 148-150
Calcite	0%	14%	14%
Dolomite	0%	0%	0%
Quartz	13%	15%	10%
Feldspar	3%	3%	4%
Layered silicates	80%	65%	67%
Pyrite	2%	1%	2%
Carb. bomb	0%	14%	14%

Grain Size:	Sec. 1 32-34
Sand	0%
Silt	52%
Clay	48%

Site 380 Hole A Core 44 Cored Interval: 731.5-741.0 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS CLAYS AND MARLS

Laminated clays and marls as Core 43.

Laminations are sharply defined. Dark laminae clay-rich, lighter laminae rich in carbonate (clay-sized, but reacts vigorously with HCl) or in diatoms.

Clay:
SS 2-26 cm
[0, 20, 80]
15% Quartz and Feldspar
55% Clay
Tr Pyrite
20% Carb., clay-sized, calcitic
10% Diatoms

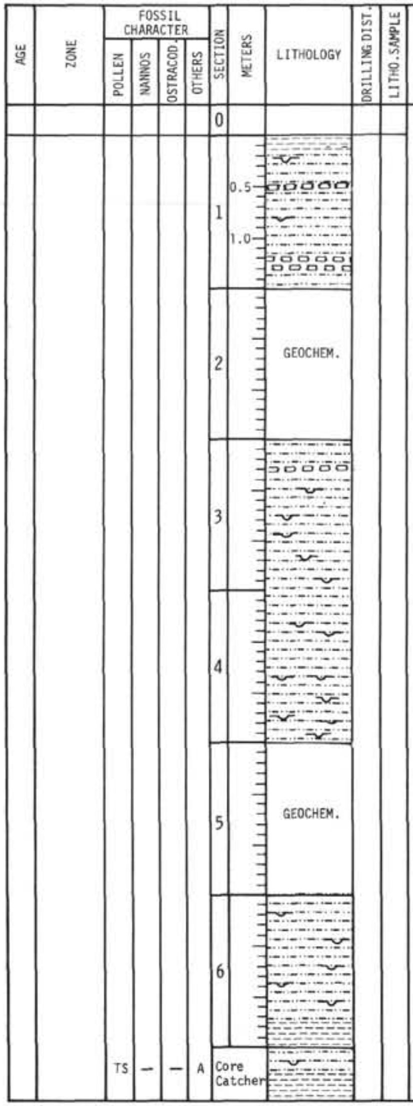
Diatomaceous clay:
SS 2-68 cm
5% Quartz and Feldspar
50% Clay
1% Pyrite
Tr Carb.
45% Diatoms

Marl:
SS 4-56 cm
10% Quartz and Feldspar
45% Clay
Tr Pyrite
30% Carb.
15% Diatoms

X-ray:	Sec. 2 32-34	37-40
Calcite	19%	36%
Dolomite	1%	0%
Quartz	3%	4%
Feldspar	0%	0%
Layered silicates	77%	57%
Carb. bomb	20%	36%

Explanatory notes in Chapter 1

Site 380 Hole A Core 45 Cored Interval: 741.0-750.5 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS MARLS AND CLAYS

Similar to Core 44.

Clay, dark olive gray (5Y 3/2).
Marl, diatom-rich, light olive gray (5Y 6/1).

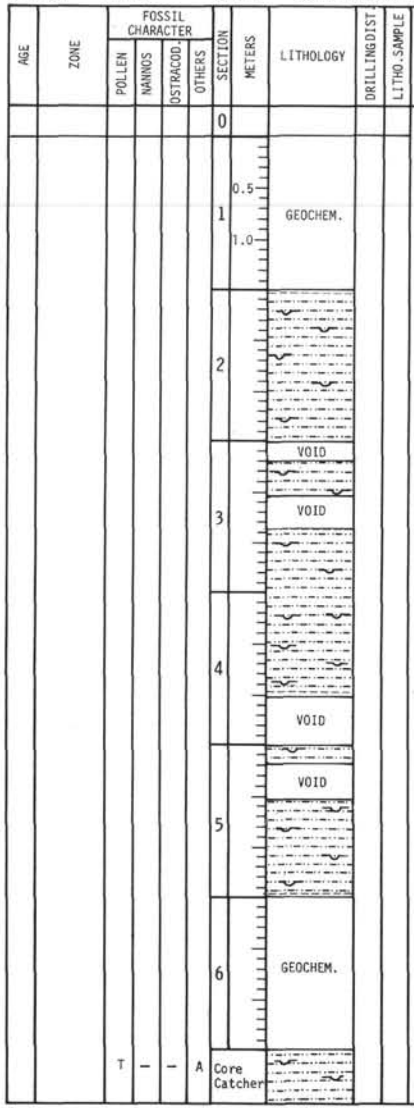
Laminations on a mm to cm scale, except some structureless intervals up to 1 cm thick in some sections.

The clays are rich in organic matter and contain no calcite.

X-ray:

	5-47 to 48
Calcite	0%
Dolomite	0%
Quartz	13%
Feldspar	3%
Layered silicates	82%

Site 380 Hole A Core 46 Cored Interval: 750.5-760.0 m



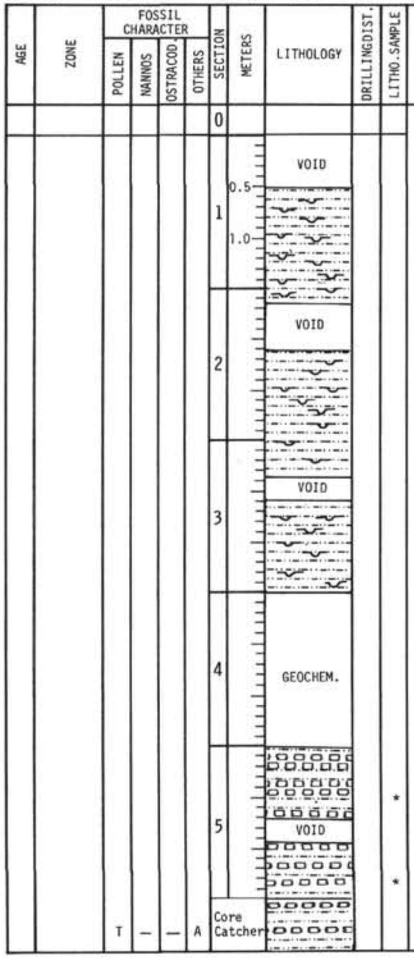
LITHOLOGIC DESCRIPTION

DIATOMACEOUS MARLS AND CLAYS

Similar to Cores 44 and 45. Laminated diatom-rich marls and clays.

Explanatory notes in Chapter 1

Site 380 Hole A Core 47 Cored Interval: 760.0-769.5 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS MARLS, CLAYS

Sections 1 to 4 are similar to Cores 44, 45, and 46.

Laminated diatomaceous marls and clays in light and dark laminae.

DIATOMACEOUS MARL

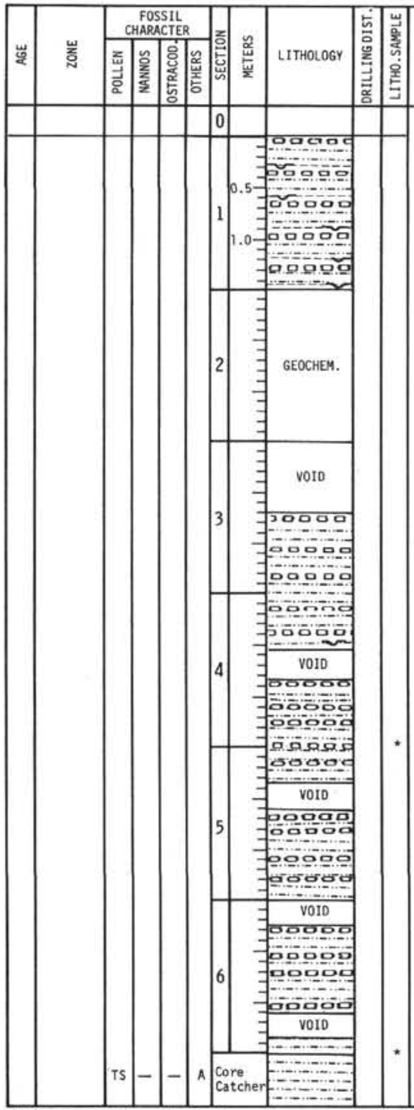
Section 5 is more calcareous and is light olive gray in color.

SS 5-137 cm:
20% Quartz and Feldspar
40% Clay
3% Pyrite
30% Carb., silt-sized, sideritic
7% Diatoms

X-ray:

	2-133 to 135	5-5 to 7
Calcite	7%	32%
Dolomite	Tr	0%
Quartz	13%	20%
Feldspar	3%	3%
Layered silicates	73%	41%
Pyrite	2%	2%
Carb. bomb	7%	32%

Site 380 Hole A Core 48 Cored Interval: 769.0-778.5 m



LITHOLOGIC DESCRIPTION

SEEKREIDE, LAMINATED, DIATOMACEOUS MUDS AND CLAYS

Similar to Core 47, Section 6, a transitional facies to seekreide.

TWO DOMINANT LITHOLOGIES:
(1) Structureless lake marl, light olive gray (5Y 5/2) with increasing calcite and decreasing diatom downward.
SS 4-145 cm
10% Quartz and Feldspar
45% Clay
Tr Pyrite
35% Carb.
10% Diatoms

SS 6-148 cm
Tr Quartz and Feldspar
50% Clay
Tr Pyrite
50% Carb., largely clay-sized

(2) Laminated marl and clay. Lamination 1 mm or thinner of dark clays and light marls as Cores 44 to 47, diatomaceous.
Marl:
SS 4-35 cm
10% Quartz and Feldspar
50% Clay
< 10% Pyrite
25% Carb.
5% Diatoms
Tr Nannos

Clay:
SS 4-36 cm
3% Quartz and Feldspar
95% Clay
2% Pyrite
Tr Carb.
Tr Diatoms

Two lithology alternates cyclically 12 cycles in Core 47, Section 6, 25-118 cm interval with marl bed thicker on the whole.

X-ray:

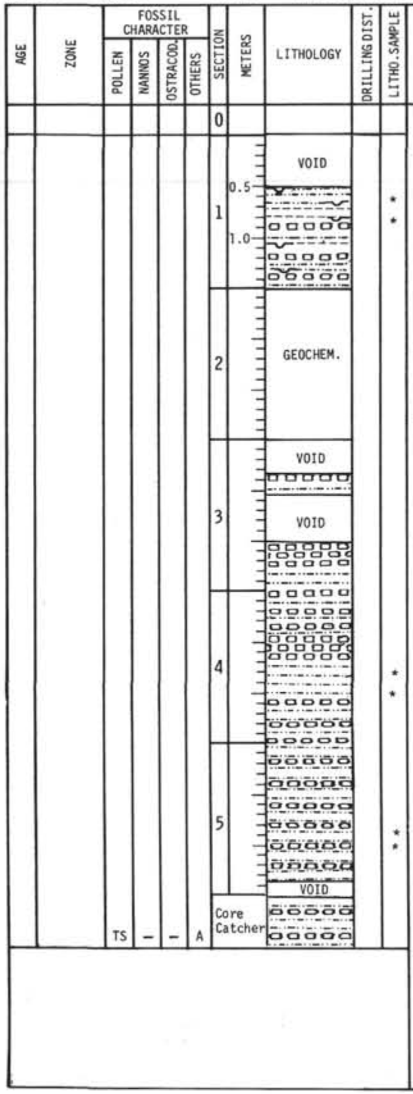
	6-60 to 61
Calcite	0%
Dolomite	0%
Quartz	11%
Feldspar	5%
Layered silicates	80%
Pyrite	2%
Carb. bomb	0%

Grain Size:

	6-60 to 61
Sand	3%
Silt	47%
Clay	50%

Explanatory notes in Chapter 1

Site 380 Hole A Core 49 Cored Interval: 778.5-788.0 m



LITHOLOGIC DESCRIPTION

MARLS, LAMINATED SEEKREIDE,
DIATOMACEOUS MARLS AND CLAYS

This core is characterized by the presence of pure carbonate laminae in laminated carbonate type of sediment, which is absent in overlying Cores 42 to 48. Cyclothem of structureless and laminated sediments, 9 cycles in Section 5, 60 to 135 cm interval, averaging 6 cm per cycle, ranging from 4 to 10 cm. Laminated sediments are thicker than structureless. Diatoms are rare or absent in lower part.

Olive gray structureless marl:
SS 1-77 cm
15% Quartz and Feldspar
40% Clay
35% Carb., mainly silt-sized
5% Pyrite
5% Diatoms

Light olive gray laminated marl:
SS 1-80 cm
5% Quartz and Feldspar
45% Clay
55% Carb., silt-sized
Tr Diatoms

Dark gray laminated marl:
SS 5-93 cm
20% Quartz and Feldspar
45% Clay
5% Pyrite and Heavy minerals
30% Carb., silt-sized
Tr Diatoms

Dark gray laminated clay:
SS 4-99 cm
<5% Quartz and Feldspar
90% Clay
2% Pyrite
5% Carb.

Light gray laminated carb.:
SS 5-96 cm
30% Clay
Tr Pyrite
70% Carb., clay-sized calcite

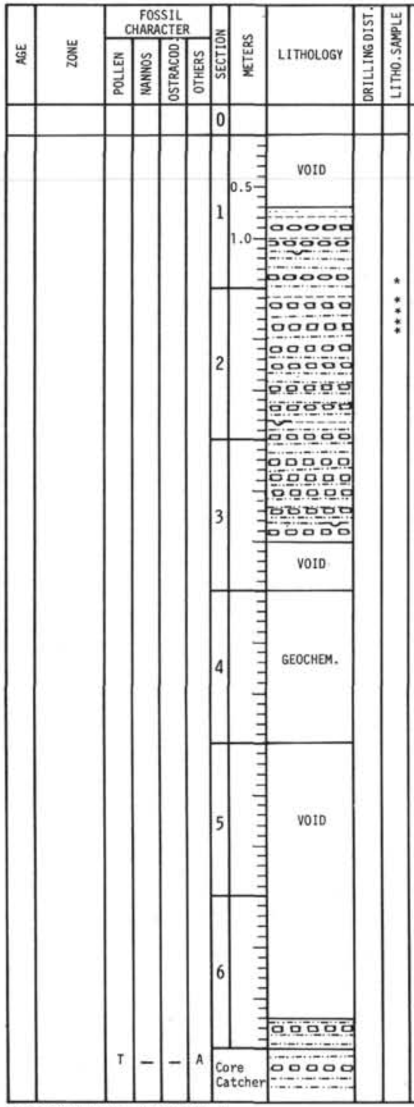
X-ray:

	5-42 to 44	5-48 to 50
Calcite	77%	55%
Dolomite	0%	Tr
Quartz	1%	5%
Feldspar	0%	0%
Layered silicates	20%	38%
Pyrite	1%	1%
Carb. bomb	77%	55%

Grain Size:

	5-42 to 44	5-48 to 50
Sand	0%	1%
Silt	65%	77%
Clay	35%	22%

Site 380 Hole A Core 50 Cored Interval: 788.0-797.5 m



LITHOLOGIC DESCRIPTION

MARLS, LAMINATED SEEKREIDE,
DIATOMACEOUS MARLS AND CLAYS

Alternation of structureless and laminated sediments.

Structureless diatomaceous marls dark greenish gray (5GY 4/1):
SS 2-28 cm
5% Quartz and Feldspar
45% Clay
Tr Pyrite
45% Carb.
5% Diatoms

Carbonate interlaminated with clays or diatomaceous marls.
Laminated carb.:
SS 1-14 cm
Tr Quartz and Feldspar
10% Clay
Tr Pyrite
90% Carb., silt-sized

Diatomaceous marl:
SS 2-20 cm
5% Quartz and Feldspar
55% Clay
Tr Pyrite
20% Carb.
20% Diatoms

Pyrite-rich clay:
SS 2-15 cm
5% Quartz and Feldspar
80% Clay and Organic
15% Pyrite
Tr Carb.
Tr Diatoms

Nine cycles in Section 2. Individual laminae ±1 mm thick, varve-like.

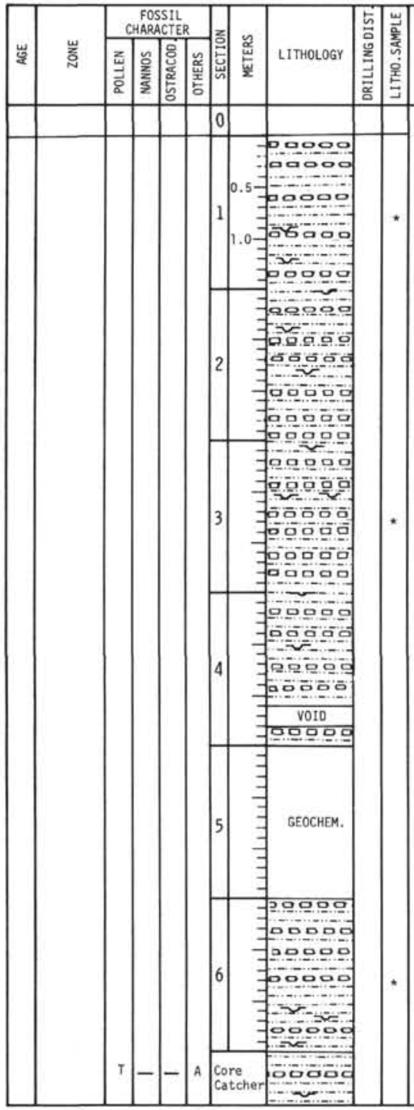
Sedimentation-rate on order of meter/10^3 years.

X-ray: Sec. 2

	9-10	12-13	14-15	15-16	19-20	26-27
Calcite	37%	80%	5%	57%	38%	54%
Dolomite	3%	0%	0%	0%	Tr	Tr
Quartz	13%	2%	15%	3%	10%	5%
Feldspar	4%	0%	4%	0%	2%	1%
Layered silicates	42%	16%	74%	38%	47%	36%
Pyrite	Tr	0%	2%	0%	1%	0%
Carb. bomb	40%	80%	5%	57%	38%	54%

Explanatory notes in Chapter I

Site 380 Hole A Core 51 Cored Interval: 797.5-807.0 m



LITHOLOGIC DESCRIPTION

MARLS, LAMINATED CARBONATE AND DIATOMACEOUS MARLS

The sequence resembles "mego-varves" except the light interval is not pure structureless seekreide (or marl), but a laminated, varve-like sediment (as in Lake Zurich) of carbonate and diatomaceous marls. Burrows between light and dark layers. The structureless marls are dark greenish gray (5G 4/1).

SS 1-53 cm
[0, 60, 40]
15% Quartz and Feldspar
60% Clay
2% Pyrite
40% Carb.
3% Diatoms

Ten to twenty cycles in each core-section, and each 1 to 3 cm laminated interval contains 8 to 15 varve-couplets. Sedimentation rate should average 1 mm/10^3 yr., and cycles range on the order of several decades.

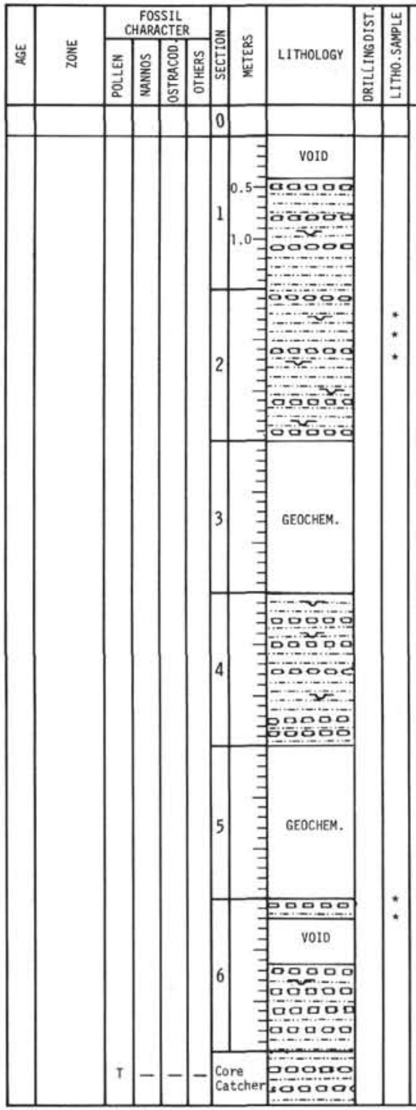
Laminated carbonate:
SS 3-76 cm
Tr Quartz and Feldspar
5% Clay
Tr Pyrite
95% Carb.

Diatomaceous marl:
SS 6-85 cm
5% Quartz and Feldspar
45% Clay
Tr Pyrite and Heavy minerals
40% Carb.
10% Diatoms

X-ray:	Sec. 1	Sec. 2	Sec. 4	
	121-123	87-100	11-13	30-34
Calcite	37%	48%	42%	52%
Dolomite	0%	0%	0%	0%
Quartz	13%	13%	10%	7%
Feldspar	3%	Tr	2%	2%
Layered silicates	44%	37%	43%	36%
Pyrite	1%	Tr	1%	Tr
Carb. bomb	37%	48%	42%	52%

Grain Size:	Sec. 2	Sec. 4
	87-100	30-34
Sand	3%	0%
Silt	67%	49%
Clay	30%	51%

Site 380 Hole A Core 52 Cored Interval: 807.5-817.0 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS MARLS AND LAMINATED SEEKREIDE MARLS (0R MUDS)

The sequence resembles "mega-varve", except the light interval is not a structureless seekreide or marl, but a laminated varve-like sediment.

Cycle:	Varves:
1-63 to 64 cm	8
1-69 to 70.5 cm	12
1-73 to 75 cm	15
1-78 to 79.5 cm	14
Total 6.5 cm	39

or 1 1/2 mm/yr. sedimentation rate.

Carbonate lamina:
SS 6-4.5 cm
Tr Quartz and Feldspar
10% Clay
Tr Pyrite
90% Carb.

Silt, dark laminae:
SS 6-4.0 cm
50% Quartz and Feldspar
Tr Mica and Heavy minerals
20% Clay
25% Carb.
Tr Diatoms

Dark marl, structureless:
SS 2-42 cm
5% Quartz and Feldspar
40% Clay
5% Pyrite
45% Carb.
5% Diatoms

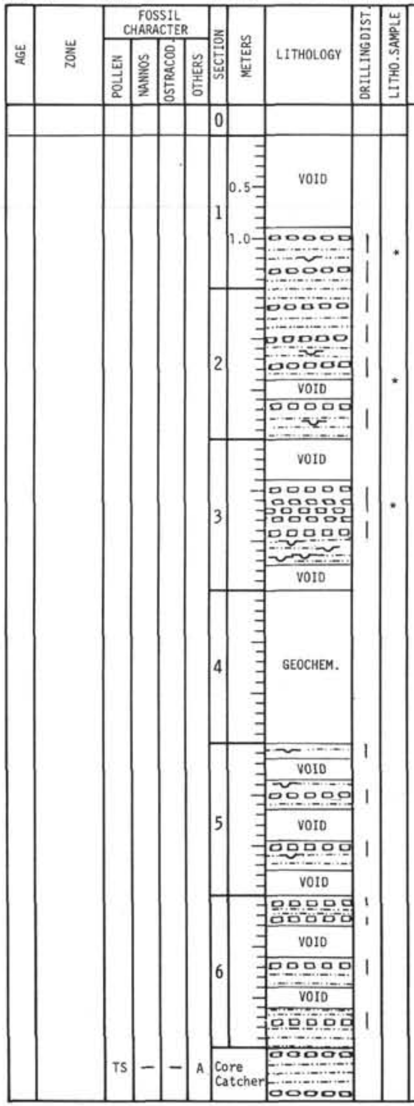
Note also the presence of Chondrite between laminated seekreide and structureless marl.

X-ray:	6-10 to 18
Calcite	66%
Dolomite	0%
Quartz	15%
Feldspar	4%
Layered silicates	13%
Carb. bomb	66%

Grain Size:	6-10 to 18
Sand	0%
Silt	63%
Clay	37%

Explanatory notes in Chapter 1

Site 380 Hole A Core 53 Cored Interval: 817.0-826.5 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS MARLS AND LAMINATED SEEKREIDE

Similar to Cores 48 to 52 "mega-varves".

Structureless marl, dark greenish gray:
SS 3-54 cm
10% Quartz and Feldspar
Tr Mica and Pyrite
45% Clay
45% Carb.
5% Diatoms

Carbonate lamina, light greenish gray (5GY 8/1):
SS 2-92 cm
5% Quartz and Feldspar
10% Clay
Tr Pyrite
85% Carb.

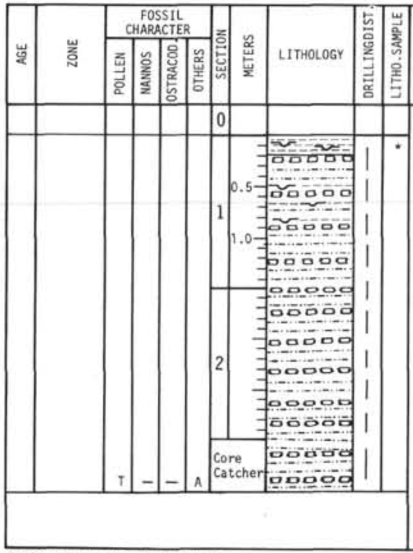
X-ray:

	2-92 to 99	3-94 to 96
Calcite	88%	39%
Dolomite	0%	0%
Quartz	1%	11%
Feldspar	0%	3%
Layered silicates	9%	45%
Carb. bomb	88%	39%

Grain Size:

	2-92 to 99	3-94 to 96
Sand	1%	2%
Silt	82%	65%
Clay	17%	33%

Site 380 Hole A Core 54 Cored Interval: 826.5-836.0 m



LITHOLOGIC DESCRIPTION

ALTERNATION OF DIATOMACEOUS MARLS AND LAMINATED SEEKREIDE

("Mega-varves")

Similar to Cores 48 to 53 with olive black diatom-rich clay.

SS 1-5 cm
Tr Quartz and Feldspar, etc.
70% Clay and Organice
30% Diatoms

X-ray:

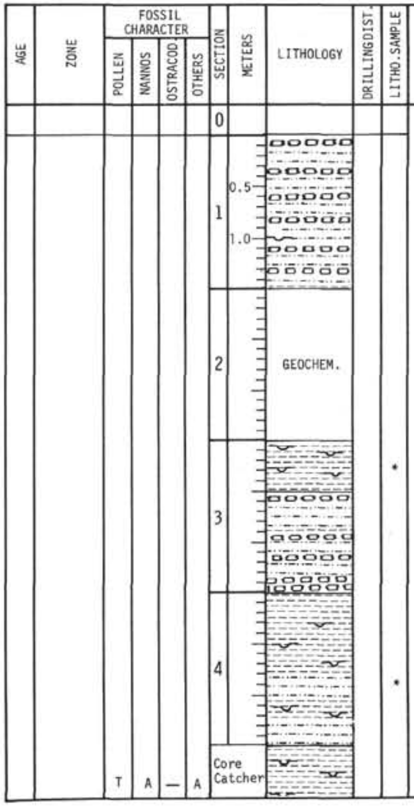
	1-12
Calcite	0%
Dolomite	0%
Quartz	4%
Feldspar	4%
Layered silicates	91%
Carb. bomb	0%

Grain Size:

	1-12
Sand	1%
Silt	43%
Clay	56%

Explanatory notes in Chapter 1

Site 380 Hole A Core 55 Cored Interval: 836.0-845.5 m



LITHOLOGIC DESCRIPTION

ALTERNATION OF DIATOMACEOUS MARLS AND LAMINATED SEEKREIDE

("Mega-varves")

SS 3-30 cm
10% Quartz and Feldspar
65% Clay
5% Pyrite and Mica
20% Diatoms

Same formation as Cores 47 to 54. Lower contact at top of Section 3 with the underlying dark gray shale.

Dark greenish gray (5GY 4/1) diatomaceous, *organic-rich clay:*
SS 4-83 cm
10% Quartz and Feldspar
75% Clay and Organic
5% Pyrite
Tr Carb.
10% Diatoms
< 1% Nannos

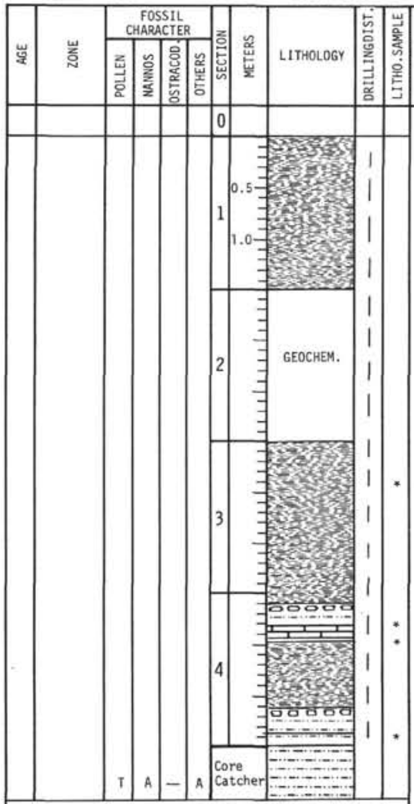
X-ray:

	3-10 to 11
Calcite	0%
Dolomite	0%
Quartz	12%
Feldspar	4%
Layered silicates	82%
Pyrite	1%

Grain Size:

	3-10 to 11
Sand	1%
Silt	74%
Clay	25%

Site 380 Hole A Core 56 Cored Interval: 845.5-855.0 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS SHALE

Olive black (5Y 2/1), diatomaceous shale, lithified and fissile, with intervals of interbedded marls and laminated seekreide in Section 4. The carbonate in the laminae is aragonite or aragonitic.

Shale:
SS 4-81 cm
5% Quartz and Feldspar
50% Clay
10% Pyrite
20% Carb.
< 5% Nannos, with Braarudosphaera
10% Diatoms

Shale:
SS 3-40 cm
Tr Quartz and Feldspar
Tr Mica and Heavy minerals
70% Clay
15% Pyrite
Tr Carb.
15% Diatoms

Carbonate lamina:
SS 4-37 cm
5% Quartz and Feldspar
15% Clay
Tr Pyrite
80% Carbonate, in part aragonitic

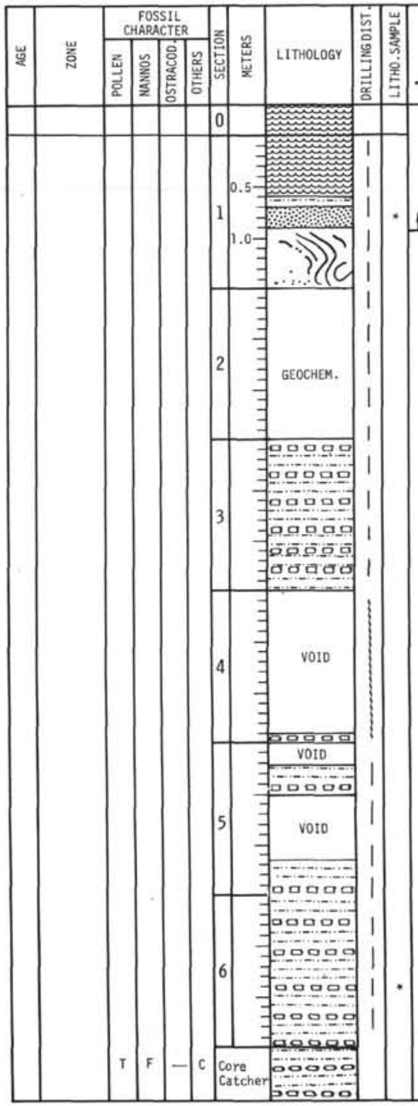
Aragonite:
SS 4-46 cm
5% Clay
95% Aragonite? (meedle-shaped crystals)

X-ray:	Sec. 3 20-22	Sec. 4 46-47	56-58	68-70	127-129
Calcite	0%	1%	3%	4%	3%
High magnesian calcite	0%	0%	6%	7%	5%
Dolomite	0%	1%	0%	1%	0%
Aragonite	0%	71%	40%	12%	46%
Quartz	13%	3%	10%	19%	13%
Feldspar	4%	0%	3%	5%	0%
Layered silicates	81%	24%	37%	55%	33%
Pyrite	1%	0%	0%	0%	0%
Carb. bomb	0%	73%	49%	24%	54%

Grain Size:	Sec. 3 20-22	Sec. 4 46-47	68-70	127-129
Sand	3%	2%	2%	0%
Silt	57%	83%	76%	61%
Clay	40%	15%	22%	39%

Explanatory notes in Chapter 1

Site 380 Hole A Core 57 Cored Interval: 855.0-864.5 m



LITHOLOGIC DESCRIPTION

TURBIDITES, MARLS, LAMINATED MARLS AND LAMINATED CARBONATE

Section 1 graded beds, slump blocks cemented siltstone gray olive (10Y 4/2) and marls, dark greenish gray.

SS 1-85 cm (silty sand):
[50, 30, 20]
40% Quartz and Feldspar
10% Mica
20% Clay
Tr Pyrite
30% Carb.

Sections 3 and 5, interbedding of structureless dark greenish gray (5G 1/2) marls, shales, and finely laminated seekreide, light greenish gray (5GY 8/1) "white varves", and greenish black (5GY 4/1 - 2/1) "black varves".

SS 6-105 cm ("black varve")
5% Quartz and Feldspar
65% Clay and Organic
10% Pyrite
25% Carb. (with unidentified fossil)
Tr Nannos

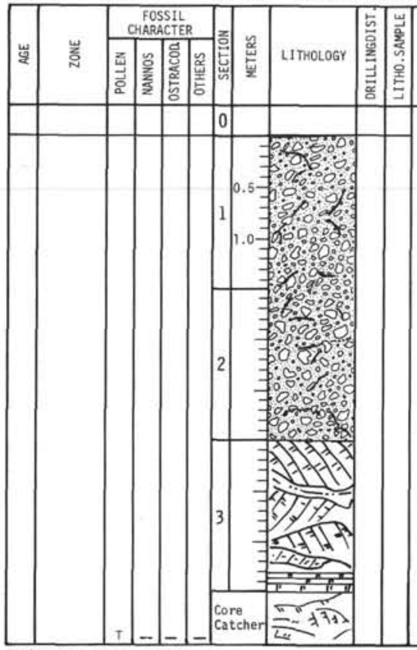
SS 1-65 cm ("white varve")
10% Quartz and Feldspar
30% Clay
60% Carb.
Tr Pyrite

"Black varves" dominant in Section 6. Varve couplets are less than 1 mm thick, some 8 to 10 cm per 1/2 cm.

X-ray:	Sec. 1			Sec. 2	Sec. 3
	65-67	140-145	145-150	64-66	73-75
Calcite	48%	7%	5%	3%	2%
High magnesian calcite	0%	12%	12%	11%	3%
Dolomite	3%	Tr	2%	1%	0%
Aragonite	0%	12%	20%	24%	45%
Quartz	25%	16%	15%	9%	6%
Feldspar	15%	5%	2%	0%	2%
Layered silicates	9%	46%	44%	51%	41%

Grain Size:	Sec. 1	Sec. 3
	140-145	73-75
Sand	1%	2%
Silt	68%	80%
Clay	31%	18%

Site 380 Hole A Core 58 Cored Interval: 864.5-874.0 m



LITHOLOGIC DESCRIPTION

BRECCIA, PEBBLY MUDSTONE

Sections 1 and 2 "slump breccia" and "turbidite" graded-bedding in more sandy beds. Clasts range up to cobble size, largely angular, some sub-rounded, and consist of very fine grained marly or chalky rocks of limestone.

Matrix is marly. Cement is carbonate, in part dolomite; cementation varies in degree.

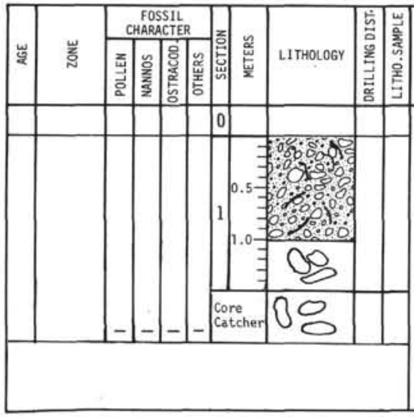
SS 3-55 cm (marly matrix):
5% Quartz and Feldspar
Tr Mica and Heavy minerals
30% Clay
5% Pyrite and Opaque
60% Carbonate (dolomite)

Section 3, hard limestone reflector, bedding inclined >80°, a cemented slump block. Cementation took place after slump.

X-ray:	3-142 to 150	CC
Calcite	55%	53%
Dolomite	29%	36%
Quartz	2%	1%
Feldspar	0%	0%
Layered silicates	14%	10%
Carb. bomb	84%	89%

Explanatory notes in Chapter 1

Site 380 Hole A Core 59 Cored Interval: 874.0-883.5 m



LITHOLOGIC DESCRIPTION

PEBBLY MUDSTONE BRECCIA

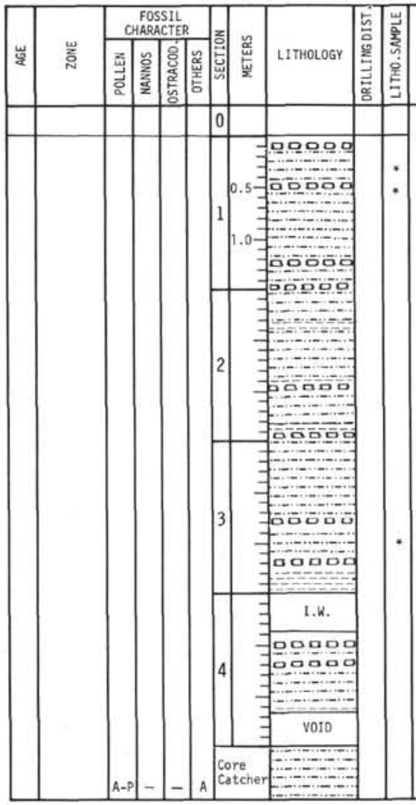
Same as Core 58.

At bottom are cobble-sized pieces of cemented rock, either cobbles in breccia, or cemented layer broken and rounded by drilling.

X-ray:

	1-145 to 147
Calcite	30%
Dolomite	60%
Quartz	2%
Feldspar	8%
Layered silicates	
Pyrite	Tr

Site 380 Hole A Core 60 Cored Interval: 883.5-893.0 m



LITHOLOGIC DESCRIPTION

LAMINATED MARLS, LAMINATED CARBONATES, STRUCTURELESS MARLS

Interbedding of 3 kinds of sediment types:
(1) Laminated marls or clay, "dark varves", dark greenish gray to olive black.
SS 1-36 cm (dark lamina):
5% Quartz and Feldspar
85% Clay
5% Pyrite
5% Carb.

(2) Laminated seekreide or marl, yellowish gray (5Y 8/1).
SS 1-35 cm:
5% Quartz and Feldspar
40% Clay
5% Pyrite
50% Carb.
Alternation of 1 and 2 in 10 to 20 cm intervals. Thick intervals are:

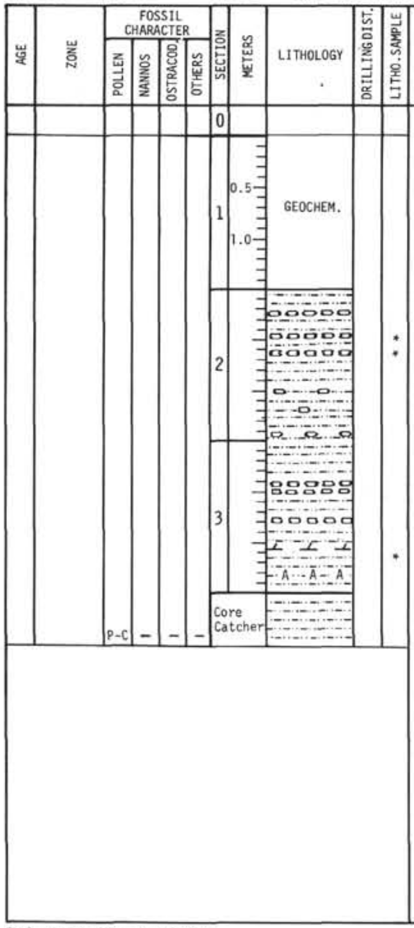
(3) Structureless marls, burrowed greenish gray (5GY 6/1) to dark greenish gray (5GY 4/1).
SS 3-97 cm:
10% Quartz and Feldspar
5% Clay
5% Pyrite
35% Carb.
Some large wood fragments are present.

X-ray:

	TOP	Sec. 1 4-5	Sec. 2 8-9
Calcite	56%	8%	26%
Dolomite	33%	0%	6%
Aragonite	0%	0%	52%
Quartz	1%	14%	9%
Feldspar	0%	7%	0%
Layered silicates	10%	70%	23%
Carb. bomb	89%	8%	32%

Site 380A, Core 61, 893.0-902.5 m (Cored 8 m, washed 1.5 m)

Site 380 Hole A Core 62 Cored Interval: 902.5-912.0 m



LITHOLOGIC DESCRIPTION

MARLS, LAMINATED MARLS AND LAMINATED CARBONATE

(1) Laminated marl ("black varve"), similar to Core 57, Section 6, greenish black, very fine laminae of < 1 mm carbonate-poor, sapropelic.
SS 2-50 cm (mud, dark):
25% Quartz and Feldspar
2% Mica
60% Clay
8% Pyrite
5% Carb.

SS 2-52 cm (marl):
10% Quartz and Feldspar
40% Clay
2% Pyrite
50% Carb.

(2) Laminated carbonate (aragonitic) ("white varves").

(3) Structureless marl, burrowed in places, varying in color from dark greenish gray (5GY 4/1), (5G 4/1), greenish gray (5GY 6/1), pale olive gray (10Y 6/2).

(4) Dolomite?, pale olive gray (10Y 6/2).

Alternation of 4 sediment types. Each interval up to tens of centimeters thick. Each laminae 0.5-1 mm thick in varve-like sediment. "Black varves" may grade into shale where gray laminations are indistinct.

X-ray:

	3-135 to 137
Calcite	2%
Aragonite	42%
Quartz	8%
Feldspar	4%
Layered silicates	43%
Carb. bomb	44%

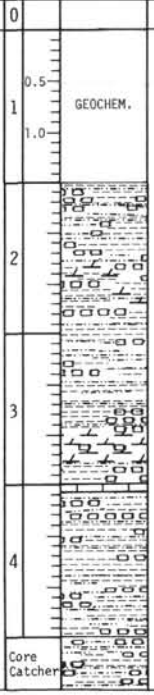
Grain Size:

	3-135 to 137
Sand	1%
Silt	70%
Clay	29%

Explanatory notes in Chapter 1

Site 380 Hole A Core 63 Cored Interval:912.0-921.5 m

AGE | ZONE | FOSSIL CHARACTER: POLLEN, NANNOS, OSTRACOD., OTHERS | SECTION | METERS | LITHOLOGY | DRILLING DIST. | LITHO.SAMPLE | LITHOLOGIC DESCRIPTION



P-F — — A

LAMINATED MARLS, LAMINATED CARBONATES, MARLS AND DOLOMITE

Alternation of 4 sediment types:

(1) Laminated marls and shale ("black varves"), greenish black (5GY 2/1).

(2) Laminated carbonate ("white varves"), 81 varves in 7.2 cm interval (or 0.9 mm/yr. estimated sedimentation rate, if annual). Aragonite(?) is found in white lamina.
SS 4-4 cm:
With pyrite
100% Aragonite

(3) Marls, structureless, or burrowed, dark greenish gray (5G 4/1).

(4) Dolomite, structurelss, pale olive gray.
SS 3-119 cm:
5% Clay
95% Dolomite

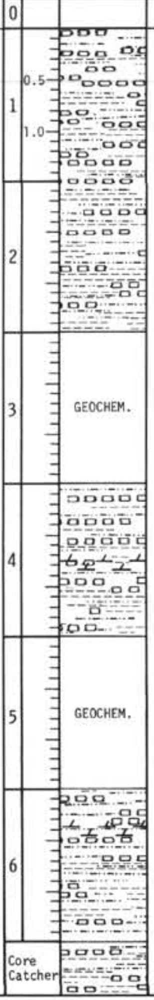
Laminated marls and marls are dominant lithologies, whereas laminated carbonated and dolomite are subordinate and minor.

X-ray:	Sec. 2 114-119	132-137	Sec. 3 120-124
Calcite	52%	0%	3%
Dolomite	26%	72%	15%
Aragonite	0%	0%	21%
Quartz	3%	8%	16%
Feldspar	0%	2%	6%
Layered	19%		
silicates	0%	15%	39%
Pyrite	78%	2%	0%
Carb. bomb		72%	39%

Grain Size:	Sec. 2 114-119	135-137	Sec. 3 120-124
Sand	1%	5%	1%
Silt	71%	78%	81%
Clay	28%	17%	18%

Site 380 Hole A Core 64 Cored Interval: 921.5-931.0 m

AGE | ZONE | FOSSIL CHARACTER: POLLEN, NANNOS, OSTRACOD., OTHERS | SECTION | METERS | LITHOLOGY | DRILLING DIST. | LITHO.SAMPLE | LITHOLOGIC DESCRIPTION



P-F — — —

LAMINATED MARLS, LAMINATED CARBONATE, MARL AND DOLOMITE

Similar to Cores 61 to 63.

Alternation of:
(1) Laminated marl or clay, greenish black (5GY 2/1).

(2) Laminated carbonate, light greenish gray (5GY 8/1).

(3) Structureless marl, greenish gray (5GY 6/1).

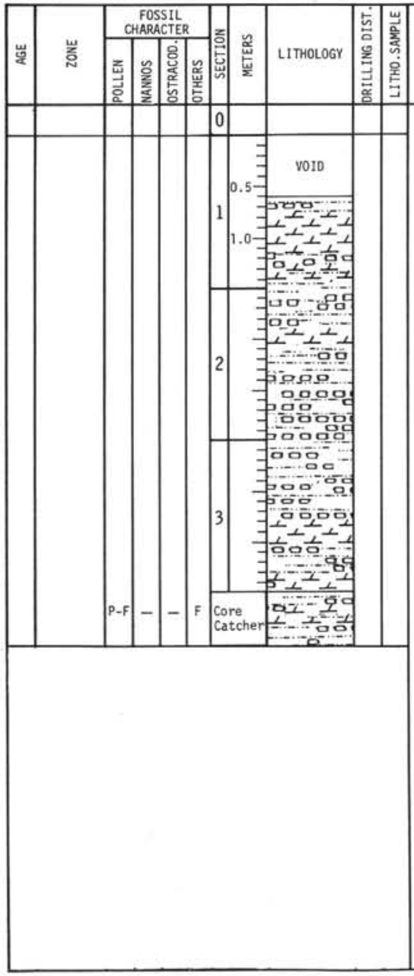
(4) Dolomite.

X-ray:	6-5 to 7	CC
Calcite	1%	22%
Dolomite	2%	1%
Quartz	20%	22%
Feldspar	7%	8%
Layered		
silicates	69%	47%
Pyrite	Tr	0%
Carb. bomb	3%	23%

Grain Size:	6-5 to 7	CC
Sand	0%	5%
Silt	70%	60%
Clay	30%	35%

Explanatory notes in Chapter 1

Site 380 Hole A Core 65 Cored Interval: 931.0-940.5 m



LITHOLOGIC DESCRIPTION

LAMINATED MARLS, SHALES,
LAMINATED CARBONATE, MARLS,
DOLOMITE

Similar to Cores 61 to 64 (65-1) type-section.

Alternation of 4 sediment-types:

(1) Laminated marls ("black varves") and shales, sapropelic fissile, traces to a few percent diatoms, dark greenish gray to greenish black.

(2) Laminated carbonate ("white varves"), lighter layer can either be calcite or aragonite, or a marl. Darker layer is usually a marl.

(3) Marl, structureless, or burrowed, dark greenish gray (5GY 4/1 to 5G 6/1).

(4) Dolomite, structureless, olive gray (5Y 5/2).

Tendency of sharp upper contact and gradational lower contact of carbonate layers.

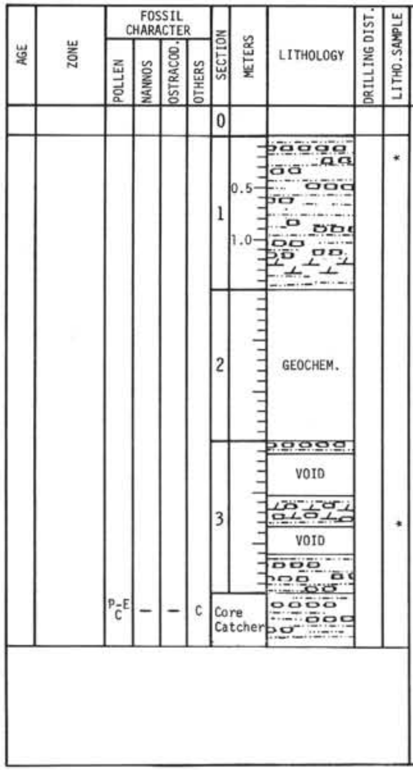
SS 3-119 cm, clay (type 1):
10% Quartz and Feldspar
10% Pyrite
2% Diatoms
70% Clay
10% Carb., Aragonite?

SS 2-155 cm, laminated carbonate (type 2):
Tr Quartz and Feldspar
Tr Pyrite
10% Clay
90% Carb.

SS 2-135 cm, marl (type 3):
5% Quartz and Feldspar
5% Pyrite
50% Clay
10% Carb.

SS 3-87 cm, dolomite
0% Quartz and Feldspar
Tr Pyrite
5% Clay
95% Dolomite

Site 380 Hole A Core 66 Cored Interval: 940.5-950.0 m



LITHOLOGIC DESCRIPTION

LAMINATED MARLS AND SHALES,
LAMINATED CARBONATE, MARLS,
AND DOLOMITE

Alternation of 4 sediment types as Cores 61 to 64.

(1) Laminated marl or clay, sapropelic, rare diatoms, greenish gray to greenish black (5GY 2-6/1), dominant in this core.
SS 3-131 cm
10% Quartz and Feldspar
60% Clay
10% Pyrite
15% Carb.
Tr Nannos and Diatoms

(2) Laminated carbonates ("varve-like"), mostly aragonite?, greenish yellow (5Y 8/4) and gray olive (10Y 4/2).
SS 1-15 cm:
2% Quartz and Feldspar
25% Clay
3% Pyrite
70% Carb., Aragonite

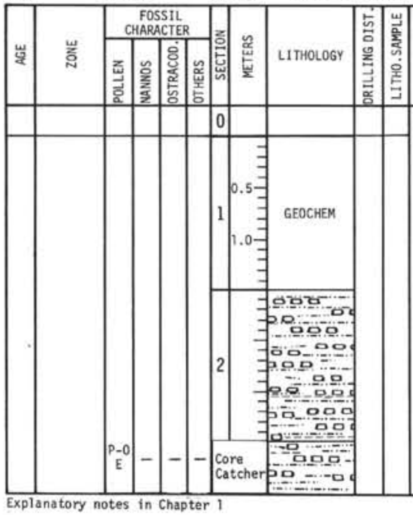
(3) Marl, structureless, or burrowed.

(4) Dolomite, pale olive (10Y 6/2).

X-ray:

	1-21 to 22	1-26 to 28
Calcite	1%	2%
High magnesian calcite	0%	Tr
Aragonite	43%	57%
Quartz	6%	7%
Feldspar	2%	3%
Layered silicates	47%	30%
Carb. bomb	44%	59%

Site Hole A Core 67 Cored Interval: 950.0-959.5 m



LITHOLOGIC DESCRIPTION

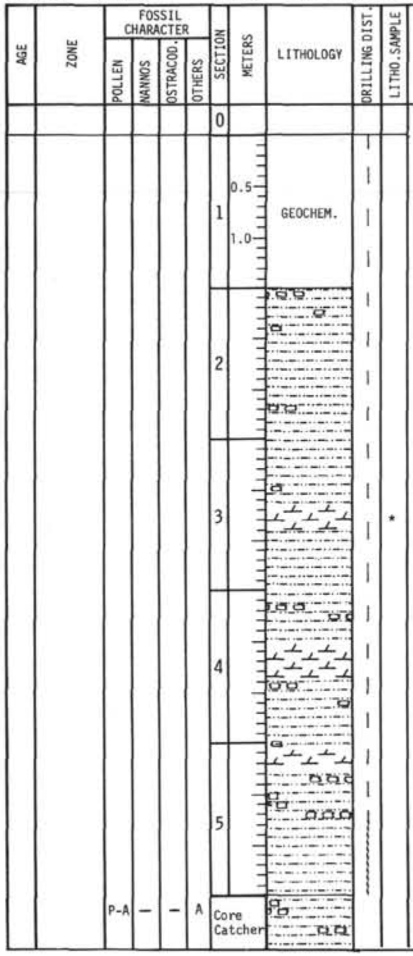
LAMINATED MARLS AND SHALES,
LAMINATED CARBONATES, MARLS

Alternation of laminated marls, laminated carbonates, and structureless marls. Similar to Cores 61 to 65.

Site 380A, Core 68, 959.5-969.0 m: NO RECOVERY

Explanatory notes in Chapter 1

Site 380 Hole A Core 69 Cored Interval: 969.0-978.5 m



LITHOLOGIC DESCRIPTION

LAMINATED MARLS AND SHALES AND DOLOMITE

The core is mainly sediment type (1) laminated marls and shales with several dolomite intervals.

The rock varies in color from dark greenish gray (5GY 4/1 and 5G 4/1) to greenish black (5G 2/1).

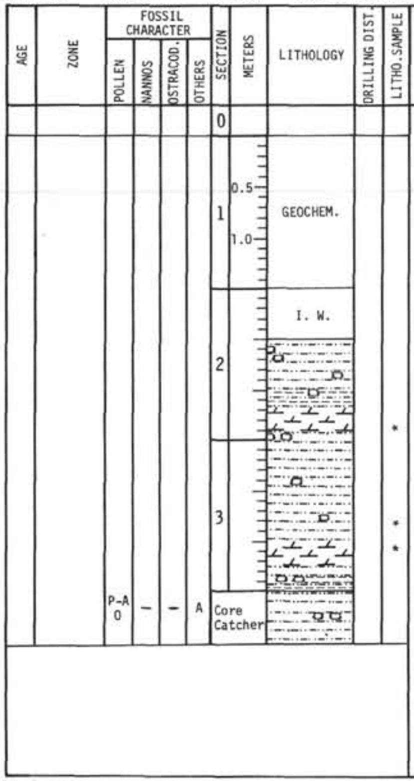
The dolomite is greenish gray (5GY 6/1).

MINOR LITHOLOGY:
SS 3-75 cm
5% Clay
Tr Pyrite
95% Dolomite

X-ray:	Sec. 3 67-69	Sec. 4 5-7	Sec. 5 15-20
Calcite	3%	5%	0%
Dolomite	21%	1%	84%
Quartz	11%	12%	3%
Feldspar	4%	5%	0%
Layered silicates	61%	77%	13%
Pyrite	Tr	Tr	0%
Carb. bomb	24	6%	84%

Grain Size:	Sec. 3 67-69	Sec. 4 5-7
Sand	2%	5%
Silt	77%	73%
Clay	22%	22%

Site 380 Hole A Core 70 Cored Interval: 978.5-988.0 m



LITHOLOGIC DESCRIPTION

LAMINATED MARLS AND SHALES, DOLOMITE, LAMINATED CARBONATES

Same as Core 69.

Laminated marls and shales, no diatoms, greenish black (5GY 2/1) with pale olive dolomite intercalations and a few laminated carbonate intercalations.

Shale:
SS 3-82 cm
20% Quartz and Feldspar
Tr Mica and Heavy minerals
60% Clay and Organic
10% Pyrite
5% Carb.

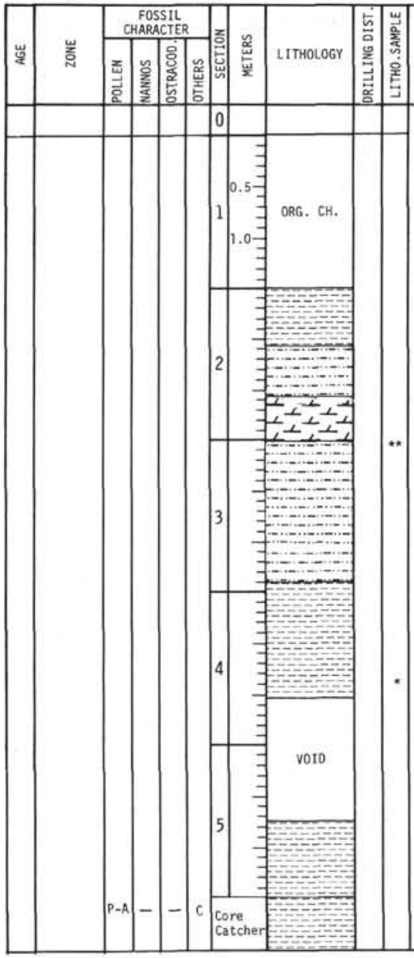
Dolomite:
SS 2-139 cm
Tr Quartz and Feldspar
5% Clay
Tr Pyrite
95% Dolomite

X-ray:	3-100 to 104	4-10 to 12
Calcite	0%	3%
High magnesian calcite	0%	9%
Dolomite	86%	0%
Quartz	3%	11%
Feldspar	0%	6%
Layered silicates	11%	69%
Pyrite	0%	1%
Carb. bomb	86%	12%

Grain Size:	4-10 to 12
Sand	2%
Silt	70%
Clay	28%

Explanatory notes in Chapter 1

Site 380 Hole A Core 71 Cored Interval: 988.0-997.5 m



LITHOLOGIC DESCRIPTION

LAMINATED MARL AND BLACK SHALE WITH DOLOMITE

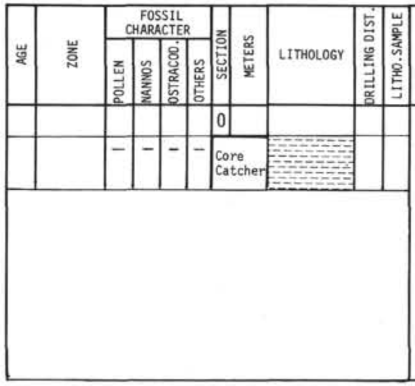
Greenish black (5GY 2/1) fissile shale, very fine laminated in some intervals, lamination < 1 mm.

Three 5 mm-thick dolomite layers at bottom of Section 2, light olive gray.

DOMINANT LITHOLOGY:
SS 4-89 cm
[0, 25, 75]
10% Quartz and Feldspar
2% Mica
75% Clay and Organic
10% Pyrite
3% Carb.

MINOR LITHOLOGY:
SS 2-146 cm
5% Quartz and Feldspar
95% Dolomite

Site 380 Hole A Core 72 Cored Interval: 997.5-1007.0 m



LITHOLOGIC DESCRIPTION

BLACK SHALE

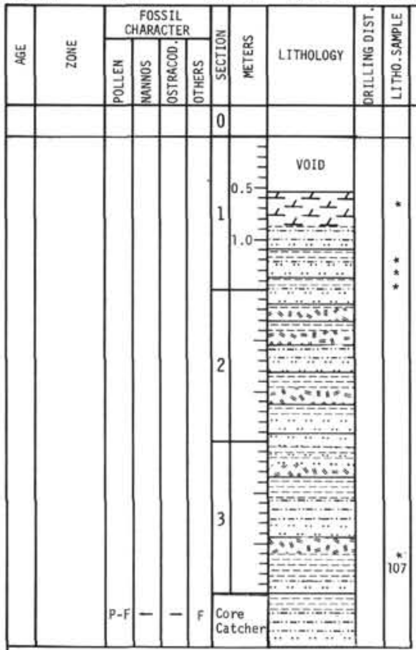
Poor recovery.

Blake shale in core catcher only with dolomite chip.

X-ray:

	CC
Calcite	0%
Dolomite	82%
Quartz	2%
Feldspar	2%
Layered silicates	14%
Carb. bomb	82%

Site 380 Hole A Core 73 Cored Interval: 1007.0-1016.5 m



LITHOLOGIC DESCRIPTION

BLACK SHALE, SILTY SAND

Dolomite intercalations.

Cyclically deposited dark gray, sediments. A typical cycle in descending order.

Shale, dark gray, pyrite-rich clay:
SS 124.5 cm
5% Quartz and Feldspar
80% Clay
>10% Pyrite
3% Carb.
Tr Forams(?), Nannos
2% Mica

grading to medium dark gray silty clay:
SS 1-125 cm
[0, 40, 60]
30% Quartz and Feldspar
5% Mica
60% Clay
5% Pyrite
Tr Zeolite? and Forams?

and usually with gray sand at base:
SS 1-127 cm
[40, 60, 0]
85% Quartz and Feldspar
5% Ash and Zeolite
8% Heavy minerals
4% Pyrite and Opaques
1% Carb.
Tr Forams

Sand is cross-laminated in Section 2. Ten cycles were recognized in Section 110 to 150 cm interval. Zeolite rich, up to 10% in Section 3.

A few dolomite intercalations are present.

SS 1-55 cm:
30% Calcite
70% Dolomite

X-ray:

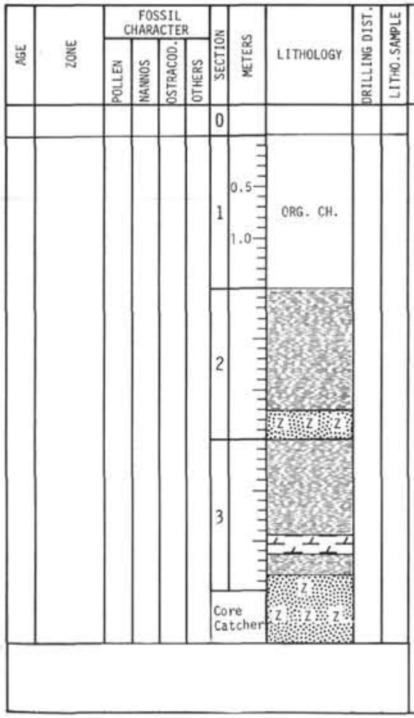
	2-146 to 148	3-28 to 36
Calcite	8%	5%
Quartz	20%	30%
Feldspar	14%	14%
Clay	10%	5%
Layered silicates	48%	46%
Carb. bomb	8%	5%

Grain Size:

	3-28 to 36
Sand	4%
Silt	59%
Clay	37%

Explanatory notes in Chapter 1

Site 380 Hole A Core 74 Cored Interval: 1016.5-1026.0 m



LITHOLOGIC DESCRIPTION

BLACK SHALE, LAMINATED SHALE

Same as Core 73, but the silty layers are fewer and thinner and the detrital silts and sands are rich in zeolites.

A few dolomite laminae are still present.

Zeolitic sandstone:
SS 2-145 cm
[55, 45, 0]
70% Quartz and Feldspar
20% Zeolite
5% Carb.
< 5% Heavy minerals

Dolomite:
SS 2-110 cm
80% Dolomite
15% Clay
< 1% Pyrite
< 1% Diatoms

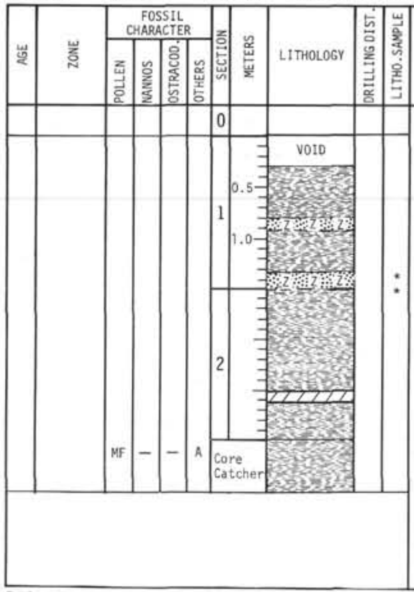
<u>X-ray</u>:

	3-127 to 130
Dolomite	61%
Quartz	10%
Feldspar	3%
Layered silicates	26%
Carb. bomb	61%

<u>Grain Size</u>:

	3-127 to 130
Sand	0%
Silt	52%
Clay	48%

Site 380 Hole A Core 75 Cored Interval: 1026.0-1035.5 m



LITHOLOGIC DESCRIPTION

BLACK SHALE, SANDY SILT

Black shale, greenish black (5GY 2/1), laminated in part, (similar to "black varves" with laminae less than 1 mm thin.

Intercalated silty and sandy layers with authigenic zeolites up to 20%.

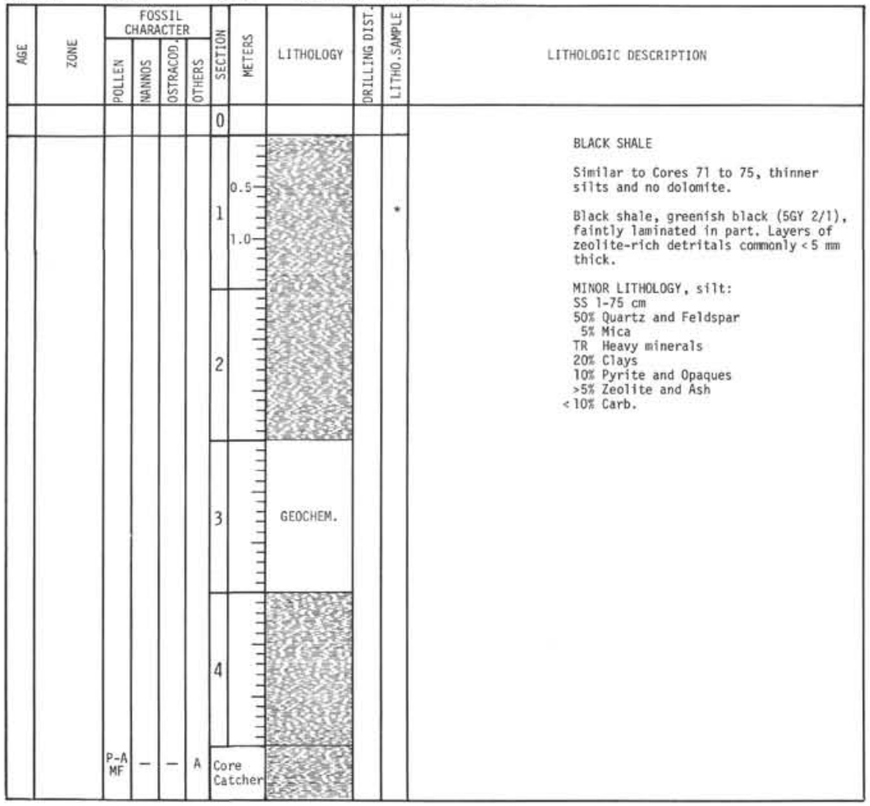
One thin dolomite interlamination.

DOMINANT LITHOLOGY, shale:
SS 1-145 cm
10% Quartz and Feldspar
5% Mica
70% Clay
5% Pyrite
< 10% Carb.

MINOR LITHOLOGY, sandy silt:
SS 1-146 cm
[30, 60, 10]
50% Quartz and Feldspar
5% Mica
TR Heavy minerals
10% Clay
5% Pyrite and Opaques
20% Zeolites
< 10% Carb.
1% Volcanic glass

Explanatory notes in Chapter 1

Site 380 Hole A Core 76 Cored Interval: 1035.5-1045.0 m



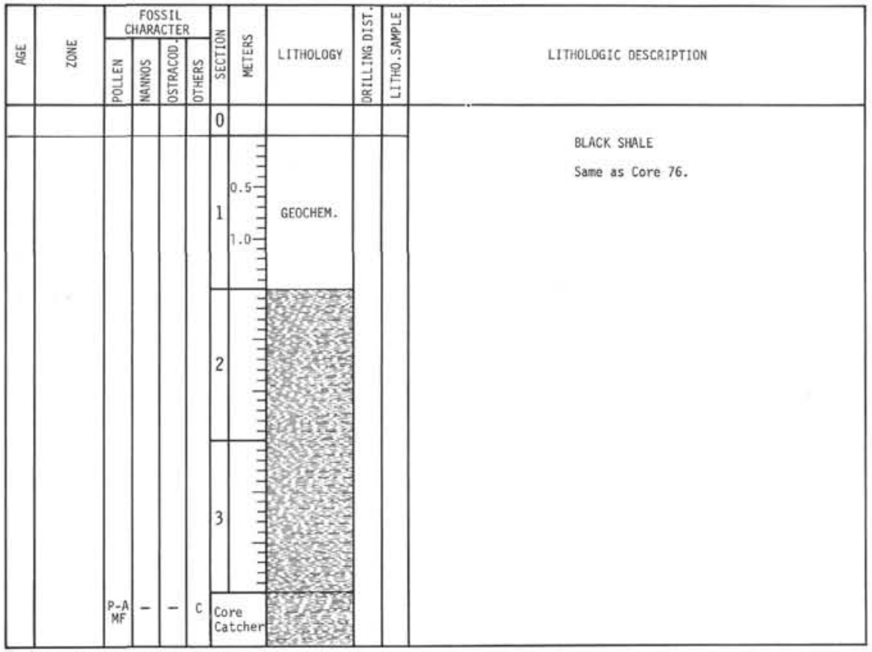
BLACK SHALE

Similar to Cores 71 to 75, thinner silts and no dolomite.

Black shale, greenish black (5GY 2/1), faintly laminated in part. Layers of zeolite-rich detritals commonly < 5 mm thick.

MINOR LITHOLOGY, silt:
SS 1-75 cm
50% Quartz and Feldspar
5% Mica
TR Heavy minerals
20% Clays
10% Pyrite and Opaques
>5% Zeolite and Ash
< 10% Carb.

Site 380 Hole A Core 77 Cored Interval: 1045.0-1054.5 m

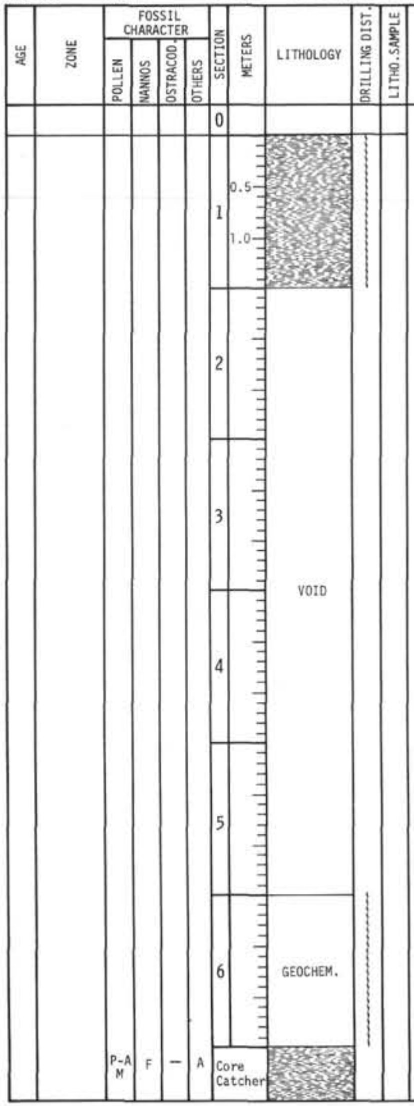


BLACK SHALE

Same as Core 76.

Explanatory notes in Chapter 1

Site 380 Hole A Core 78 Cored Interval: 1054.5-1064.0 m

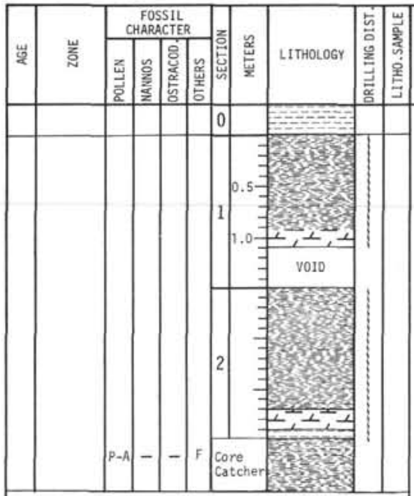


LITHOLOGIC DESCRIPTION

BLACK SHALE

Shale, finely laminated in part, fissile, olive black (5Y 2/1) as Cores 76 to 77.

Site 380 Hole A Core 79 Cored Interval: 1064.0-1073.5 m



LITHOLOGIC DESCRIPTION

BLACK SHALE

Black shale, with some volcanic ash (~10%), gray olive (10Y 4/2) to olive gray (5Y 3/2).

Intercalations of laminated dolomite.

Shale:
SS 2-80 cm
10% Quartz and Feldspar
Tr Mica and Heavy minerals
80% Clay
5% Pyrite and Opaques
5% Carb.
Tr Forams

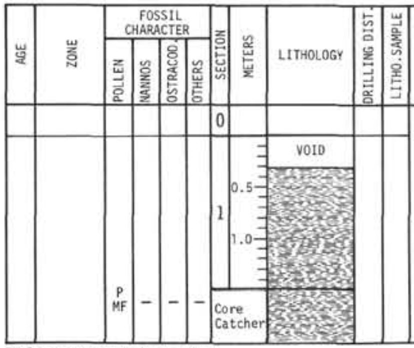
SS 2-79 cm
5% Quartz and Feldspar
75% Clay
10% Volcanic glass
3% Pyrite
2% Zeolite
5% Plant debris

SS 2-144 cm, Dolomite:
Tr Quartz and Feldspar and Mica
10% Clay
Tr Pyrite and Zeolite
90% Dolomite

X-ray:

	2-9 to 11
Dolomite	90%
Quartz	1%
Layered silicates	9%
Carb. bomb	90%

Site 380 Hole A Core 80 Cored Interval: UNINTENTIONAL, CORE IN PULLED PIPE



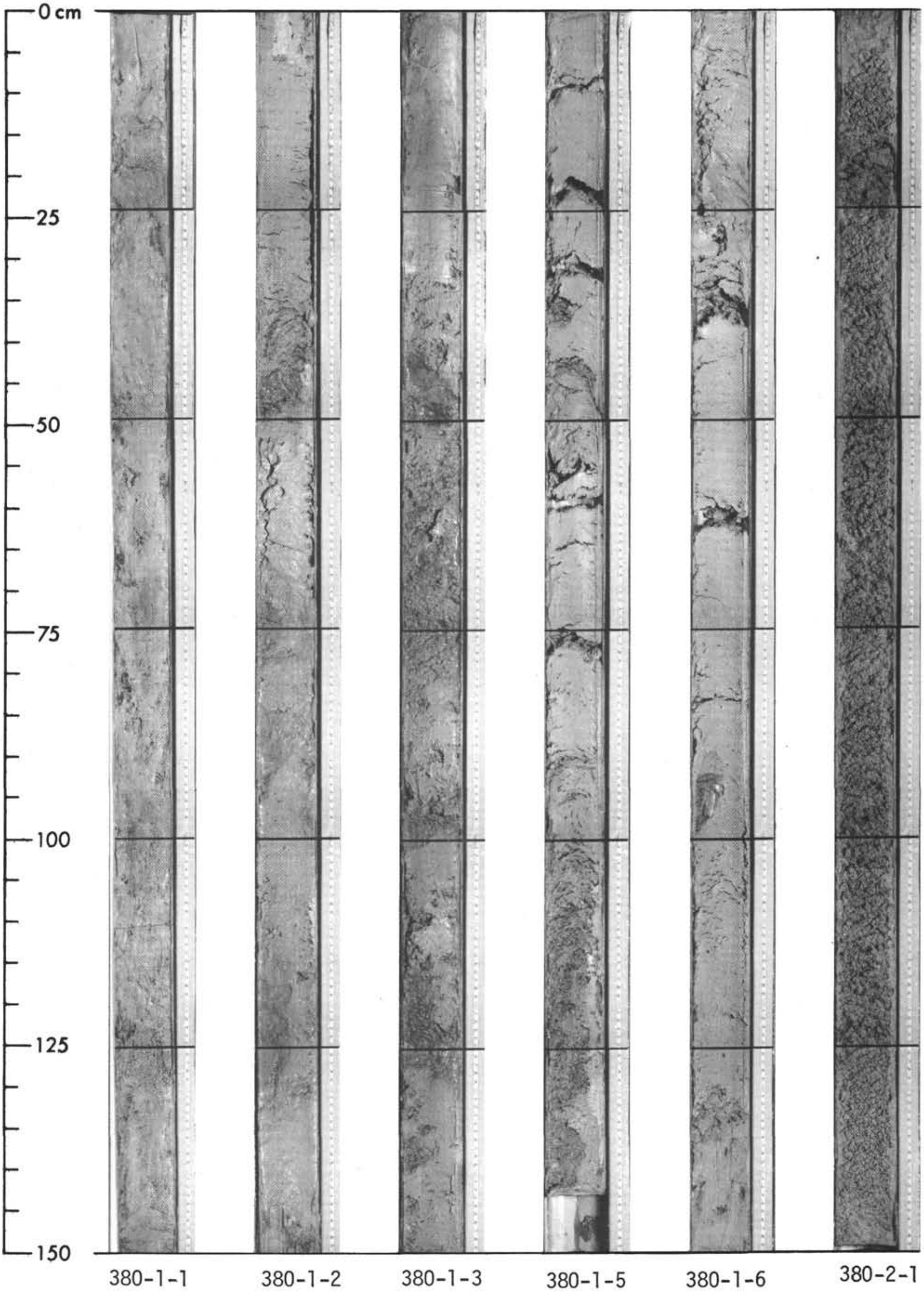
LITHOLOGIC DESCRIPTION

BLACK SHALE

Black shale, fissile, and finely laminated in part, silty, dark greenish gray (5GY 4/1).

SS 1-125 cm:
40% Quartz and Feldspar
<10% Mica and Heavy minerals
25% Clay
10% Pyrite
10% Carb.
5% Ash and Zeolite

Explanatory notes in Chapter 1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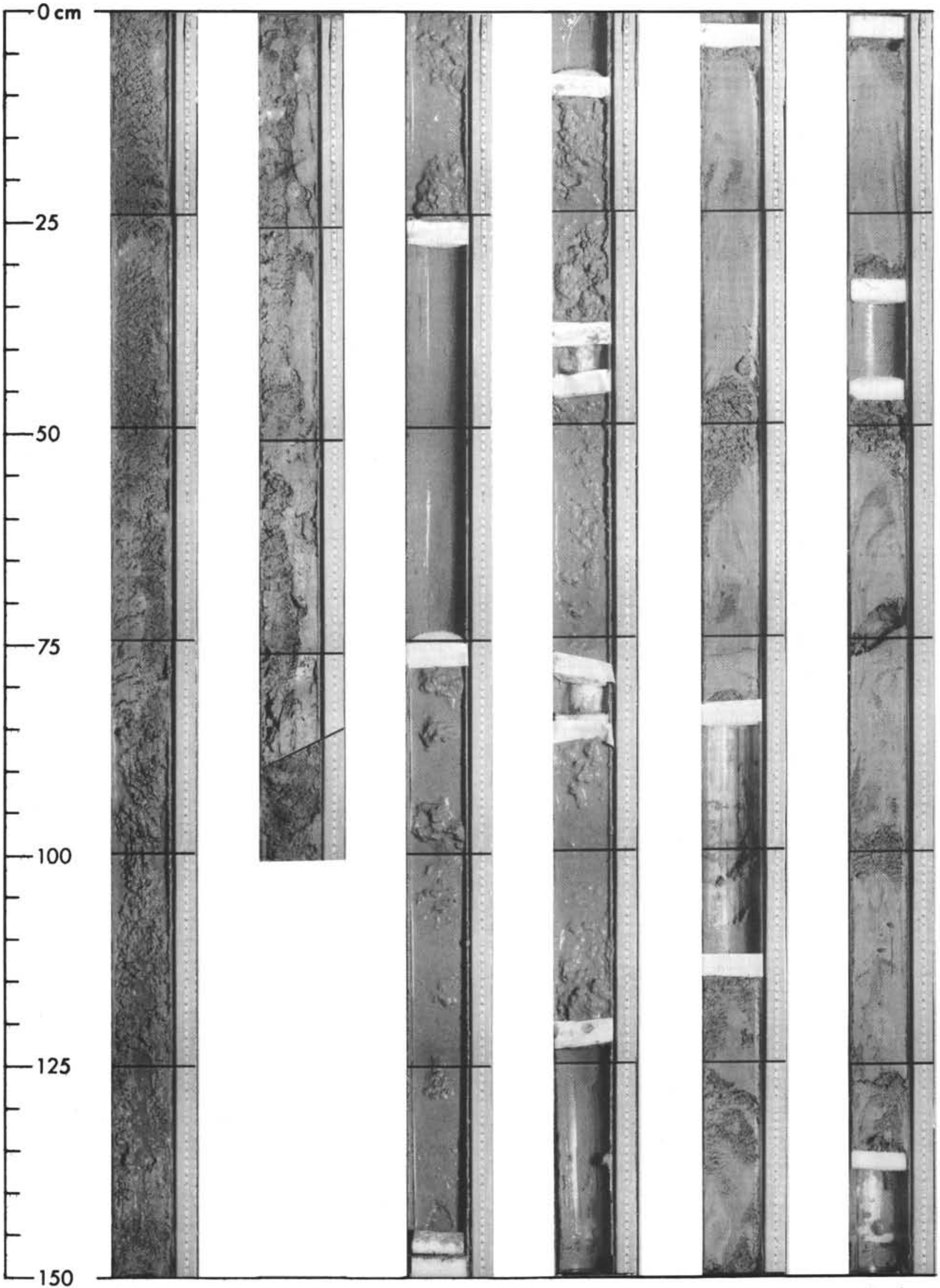
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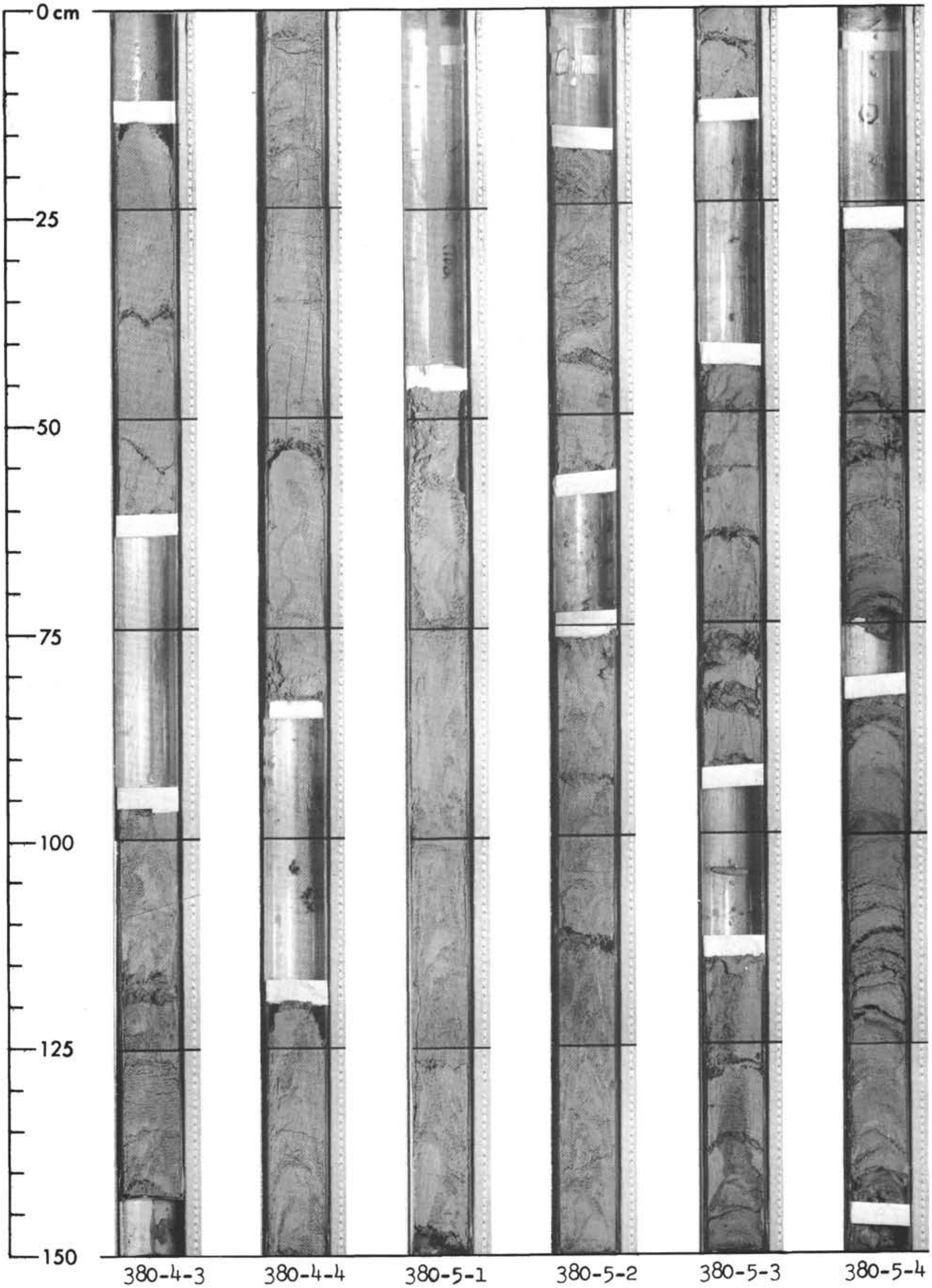
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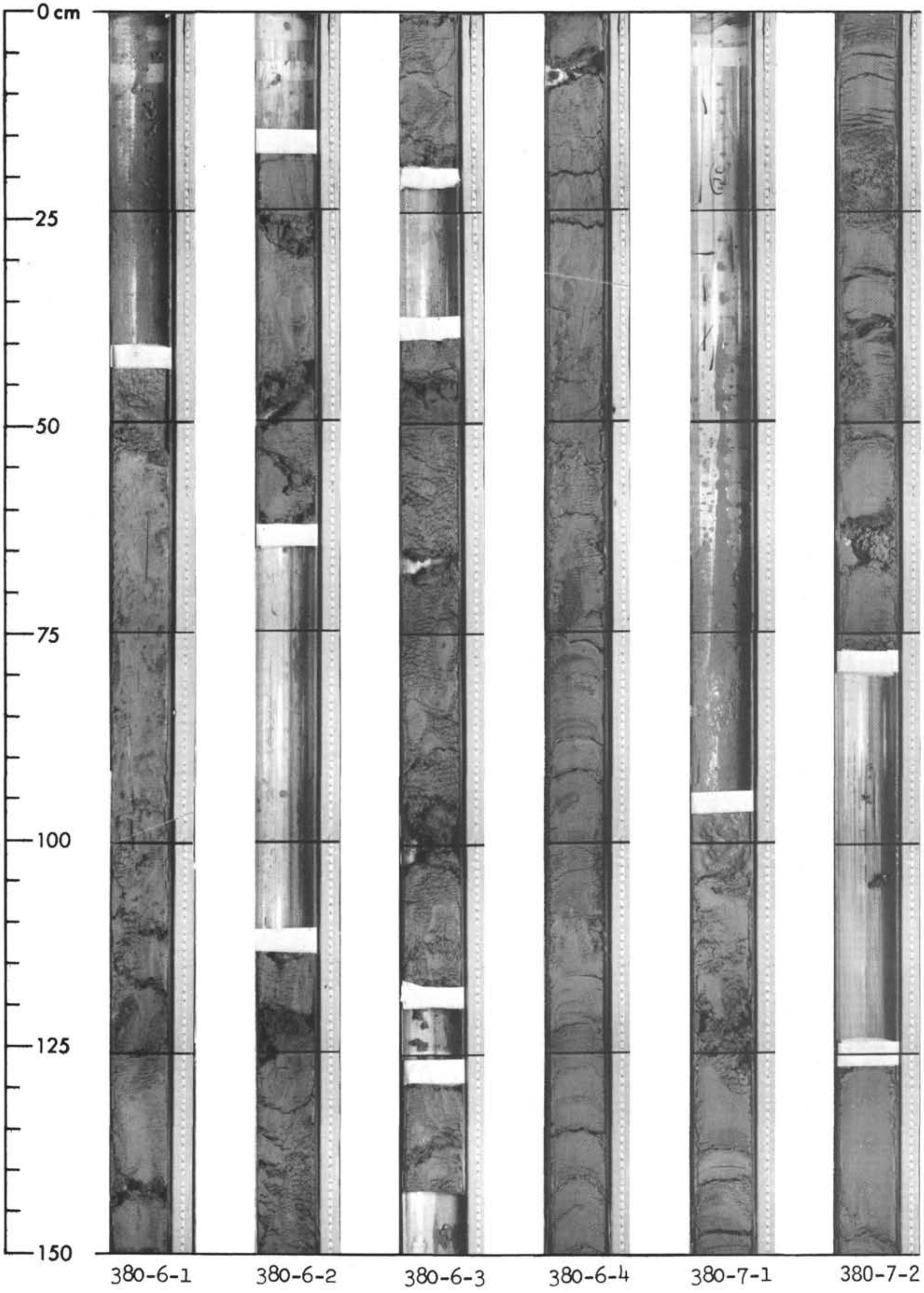
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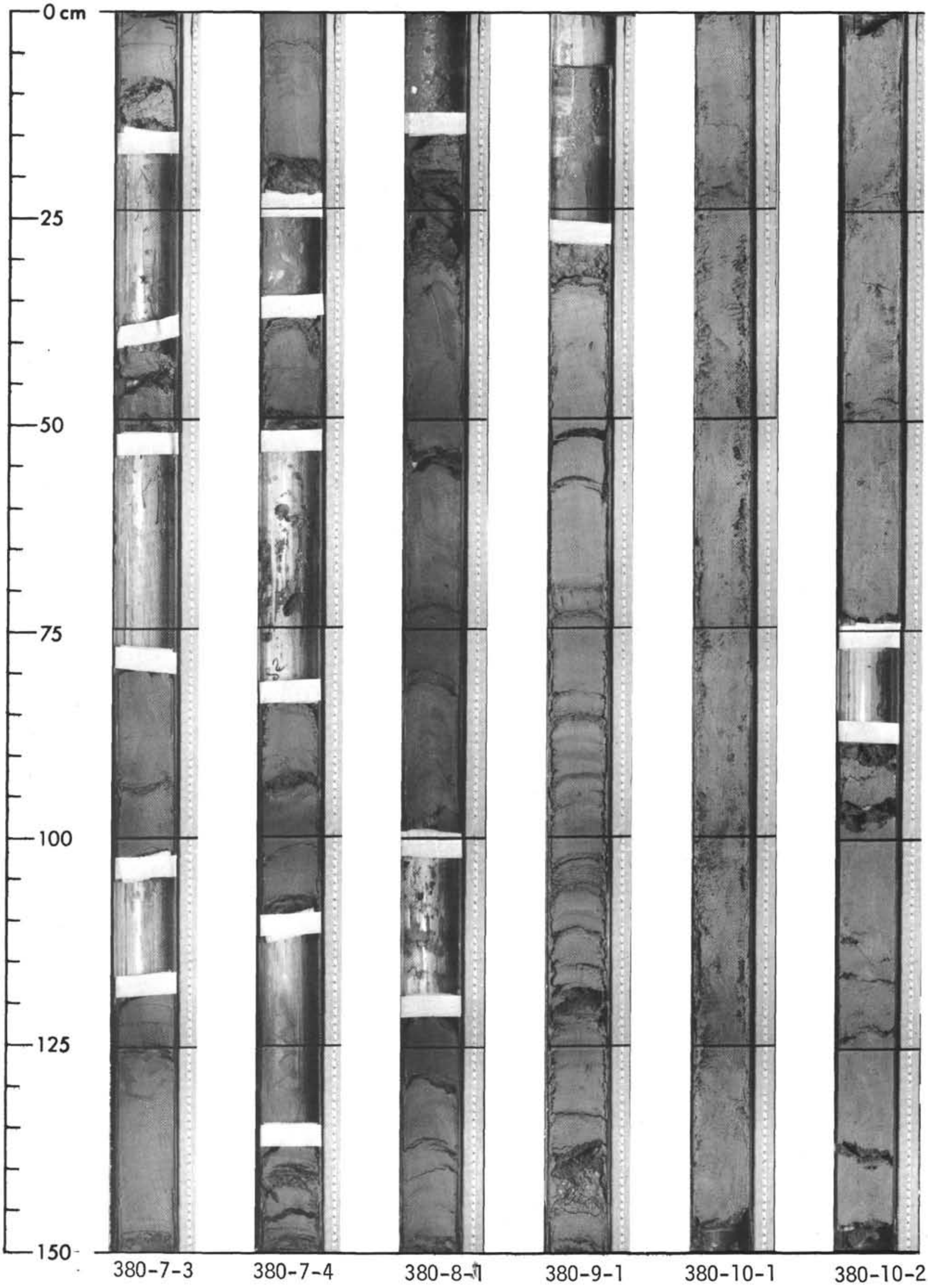
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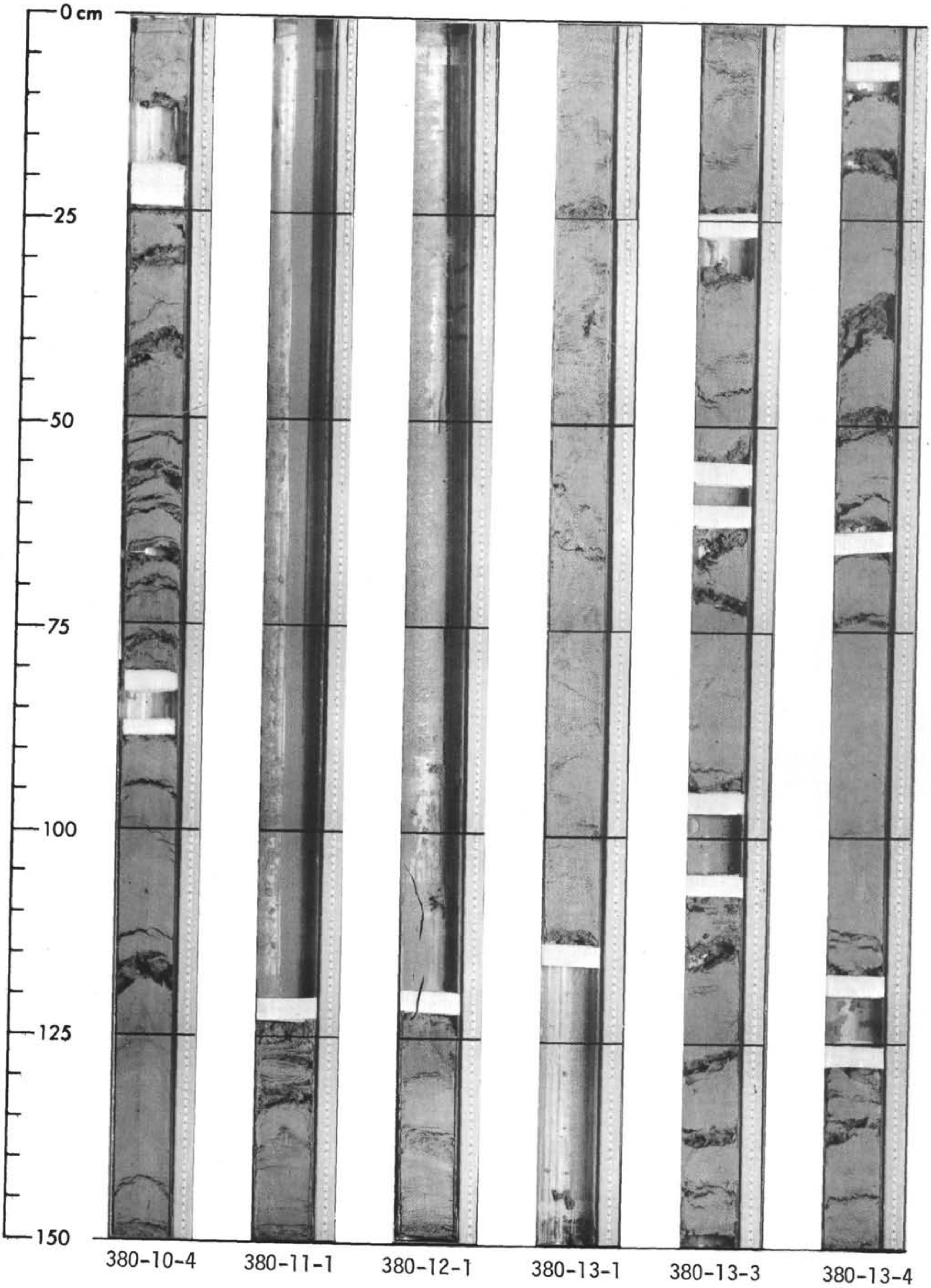
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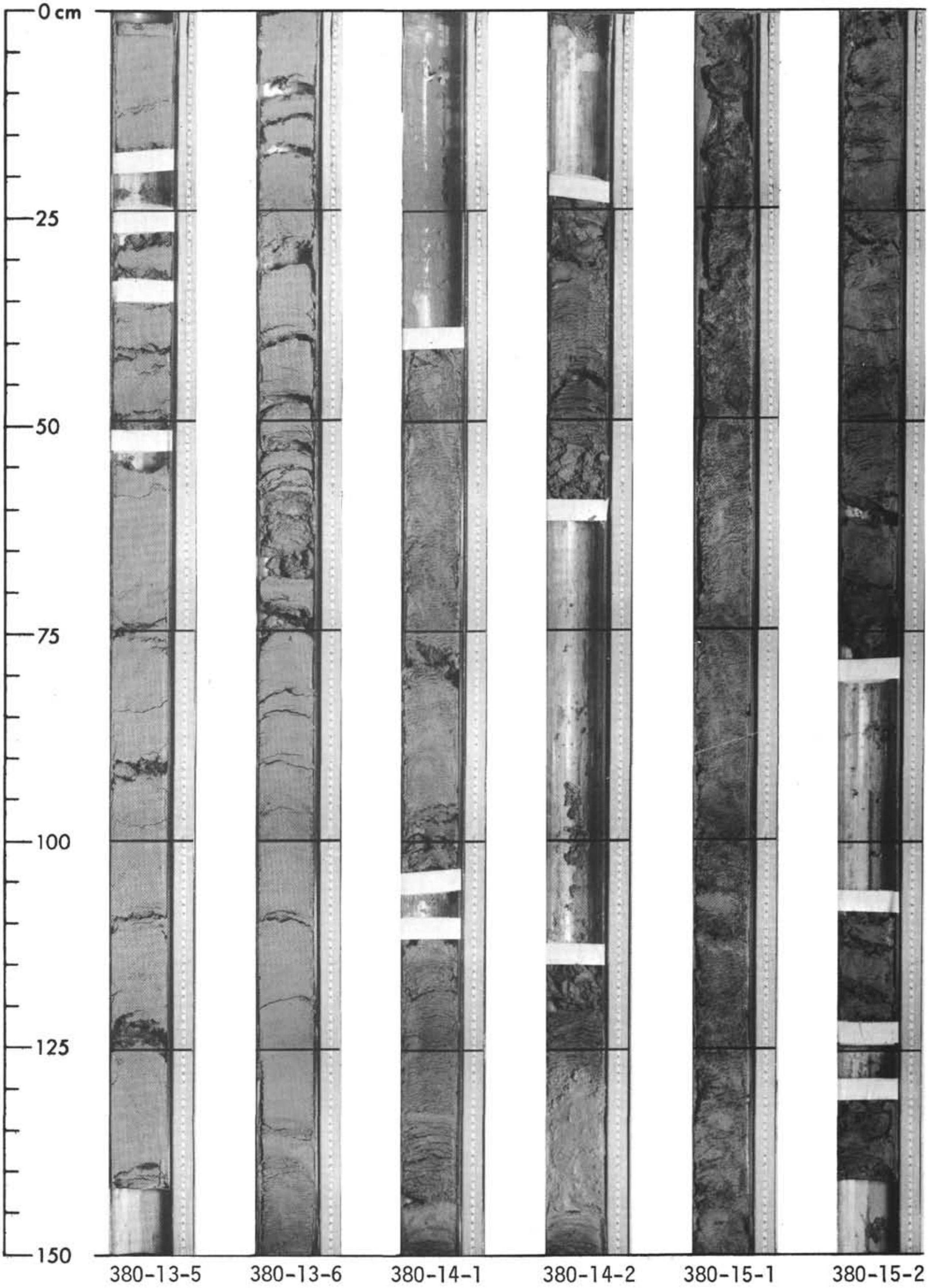
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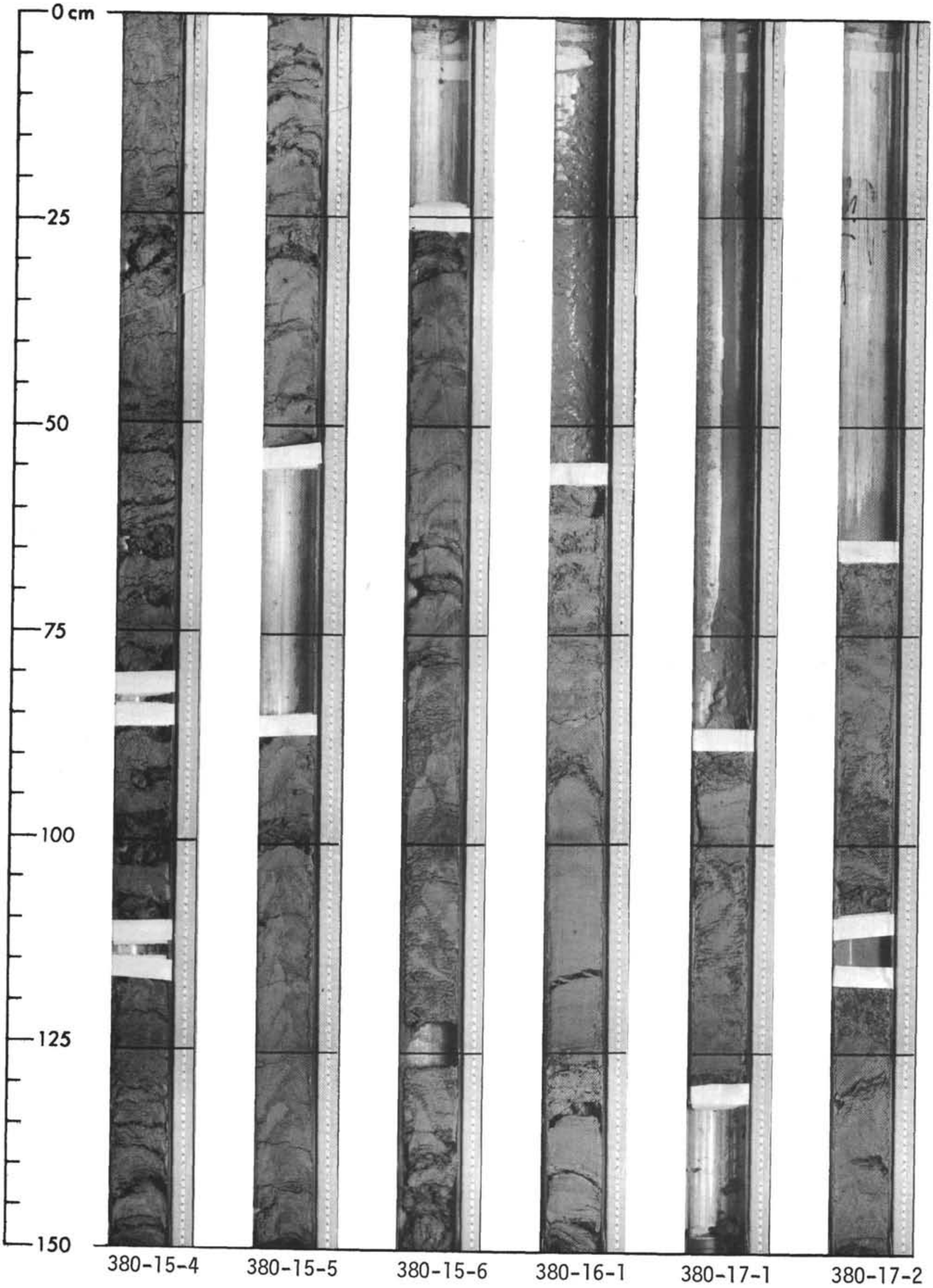
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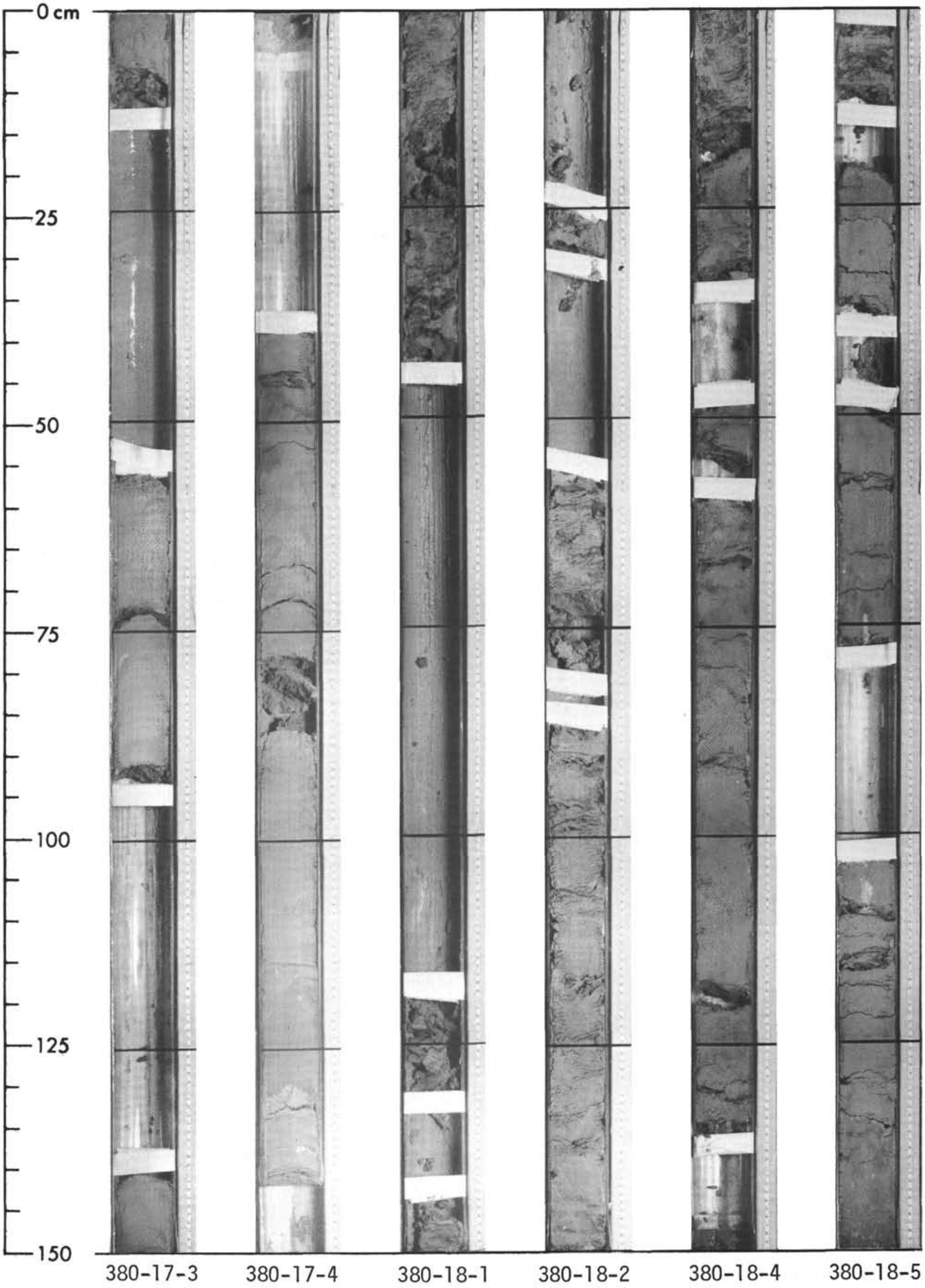
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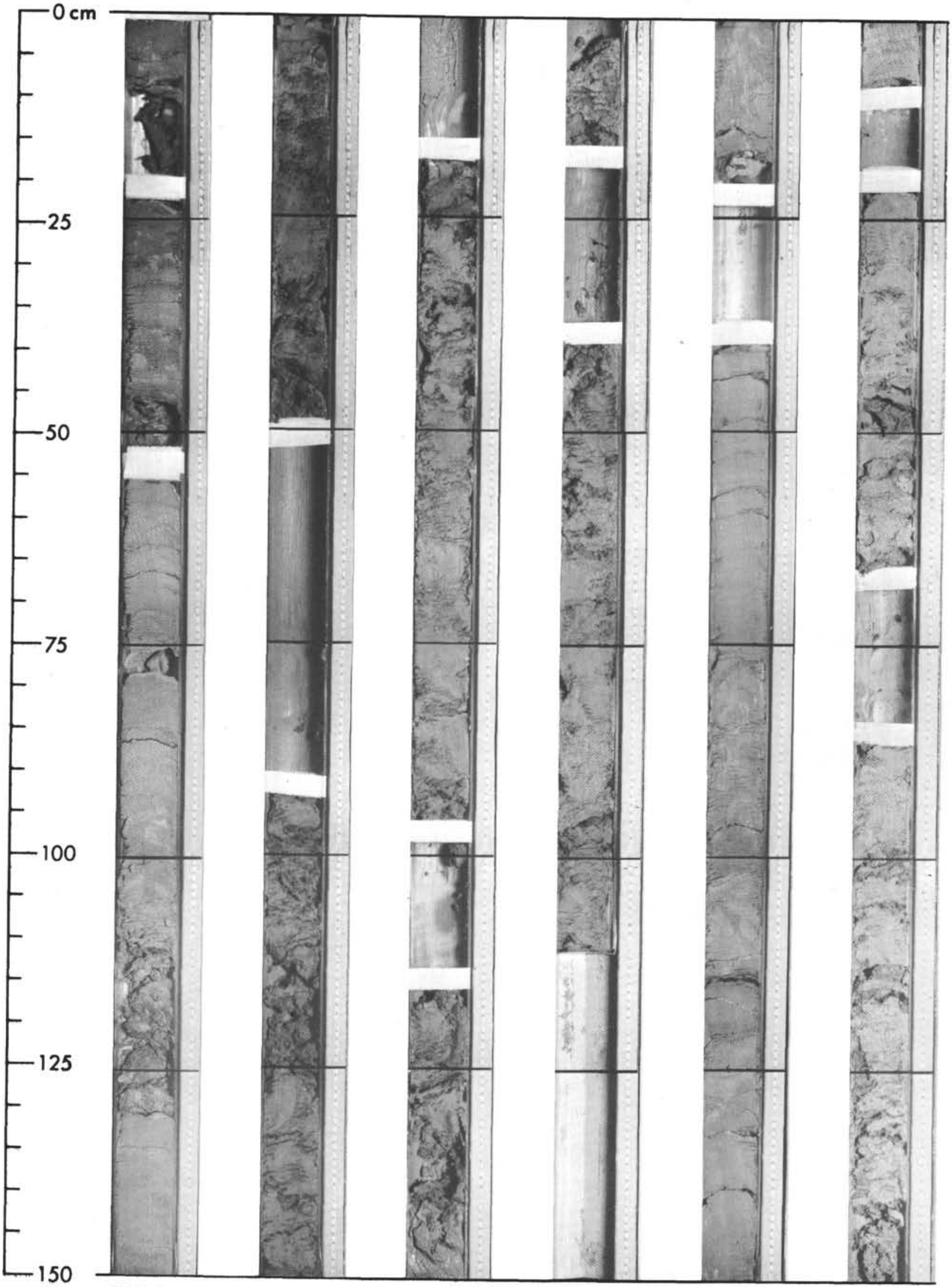
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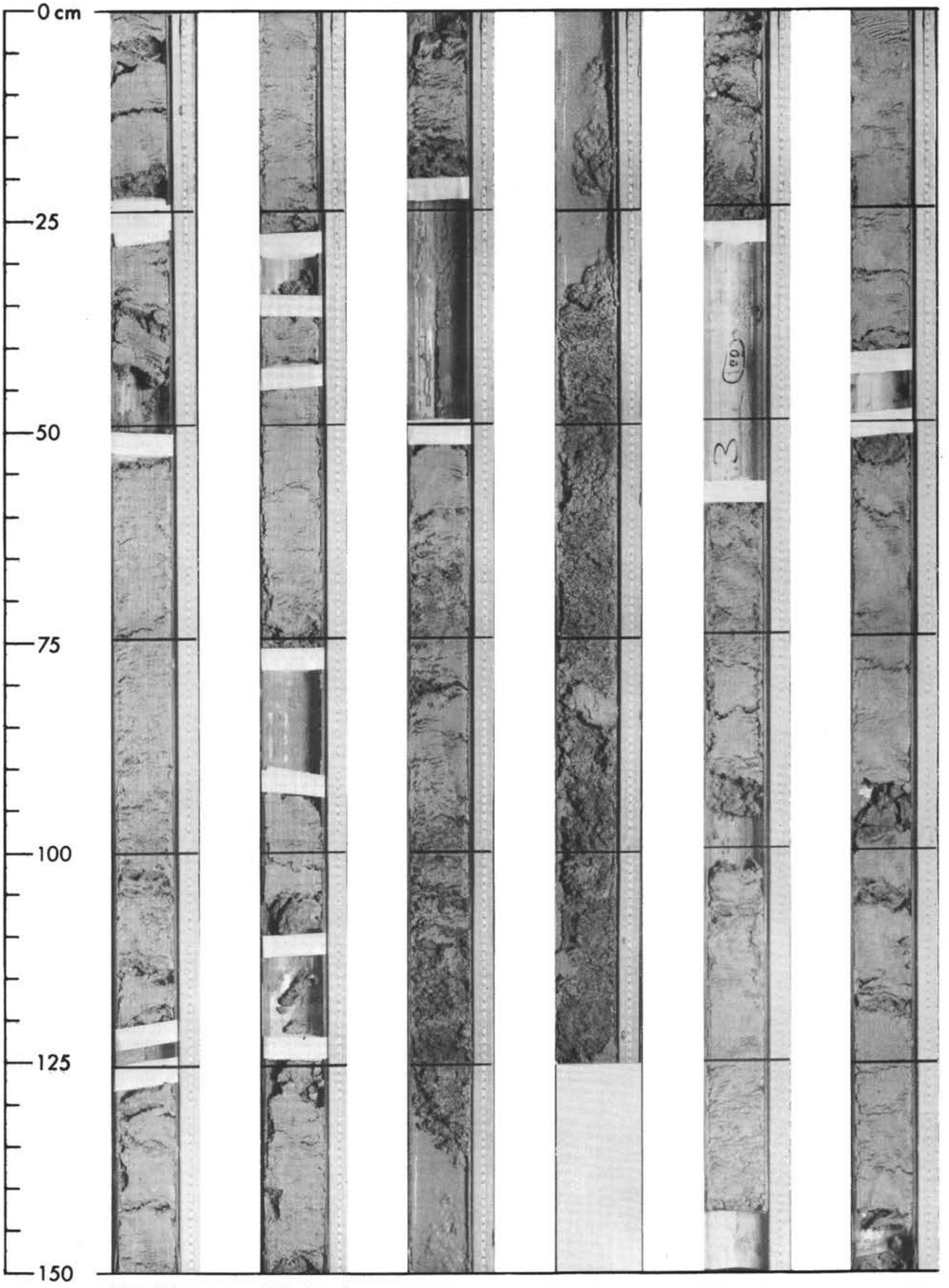
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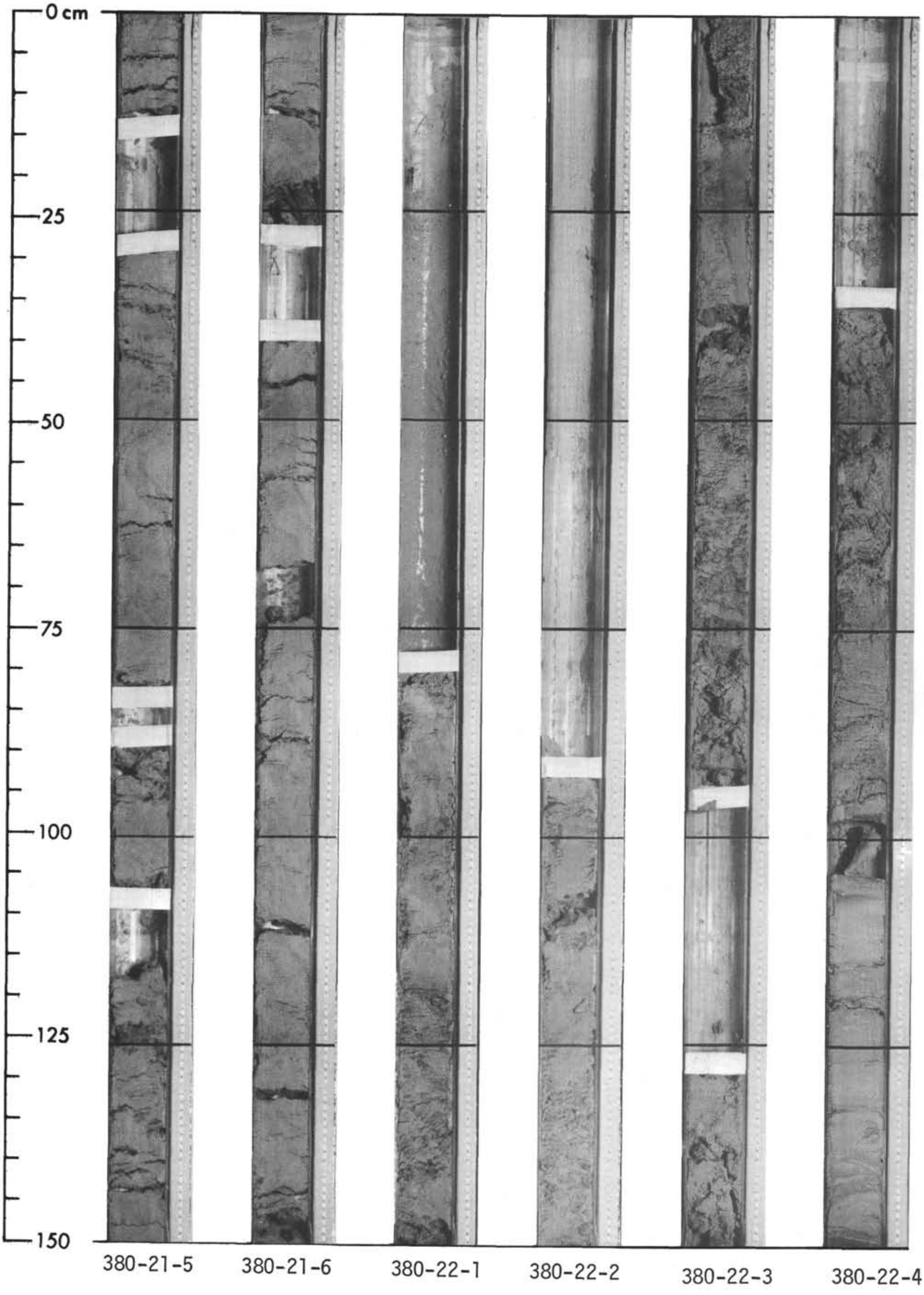
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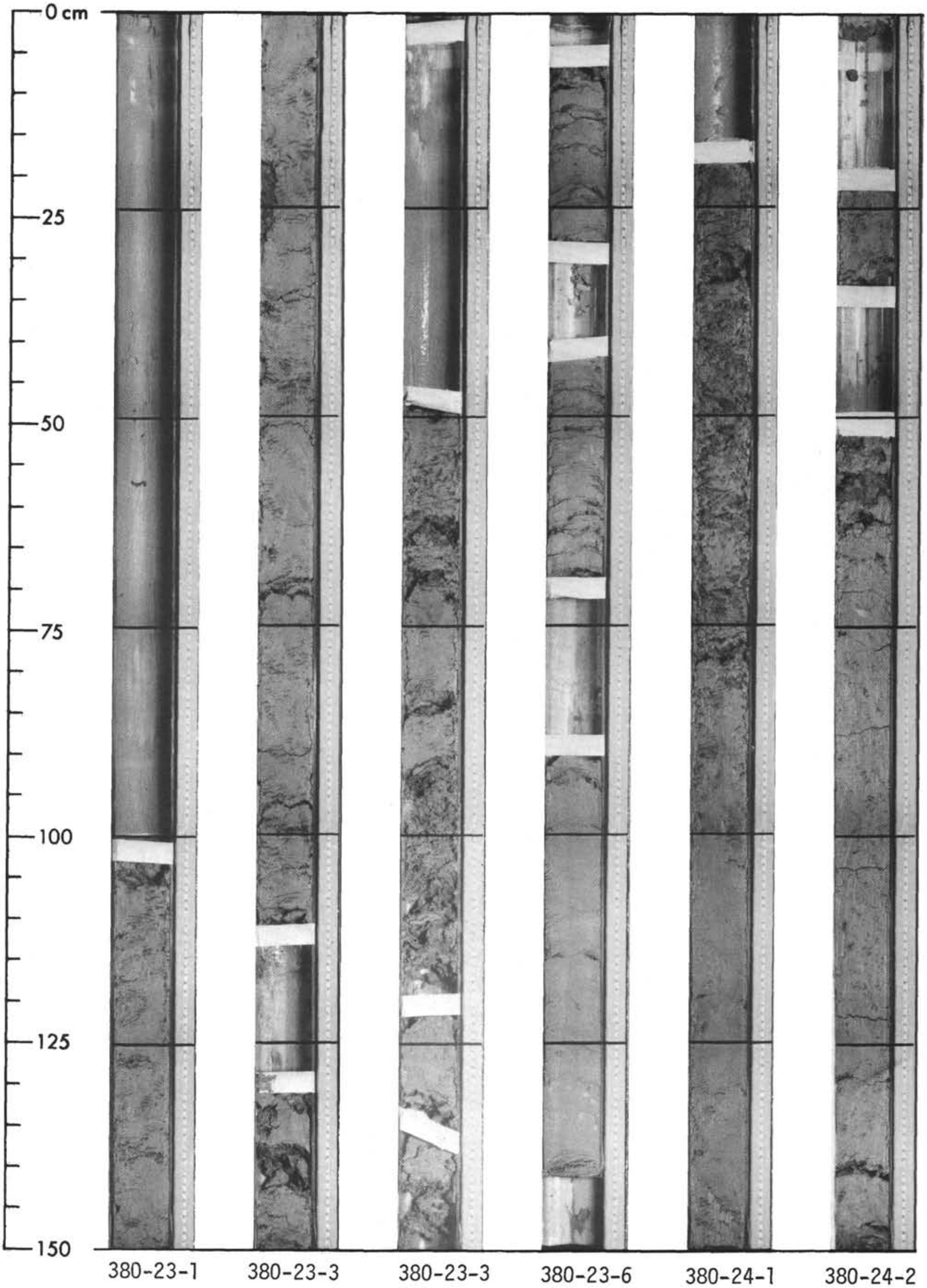
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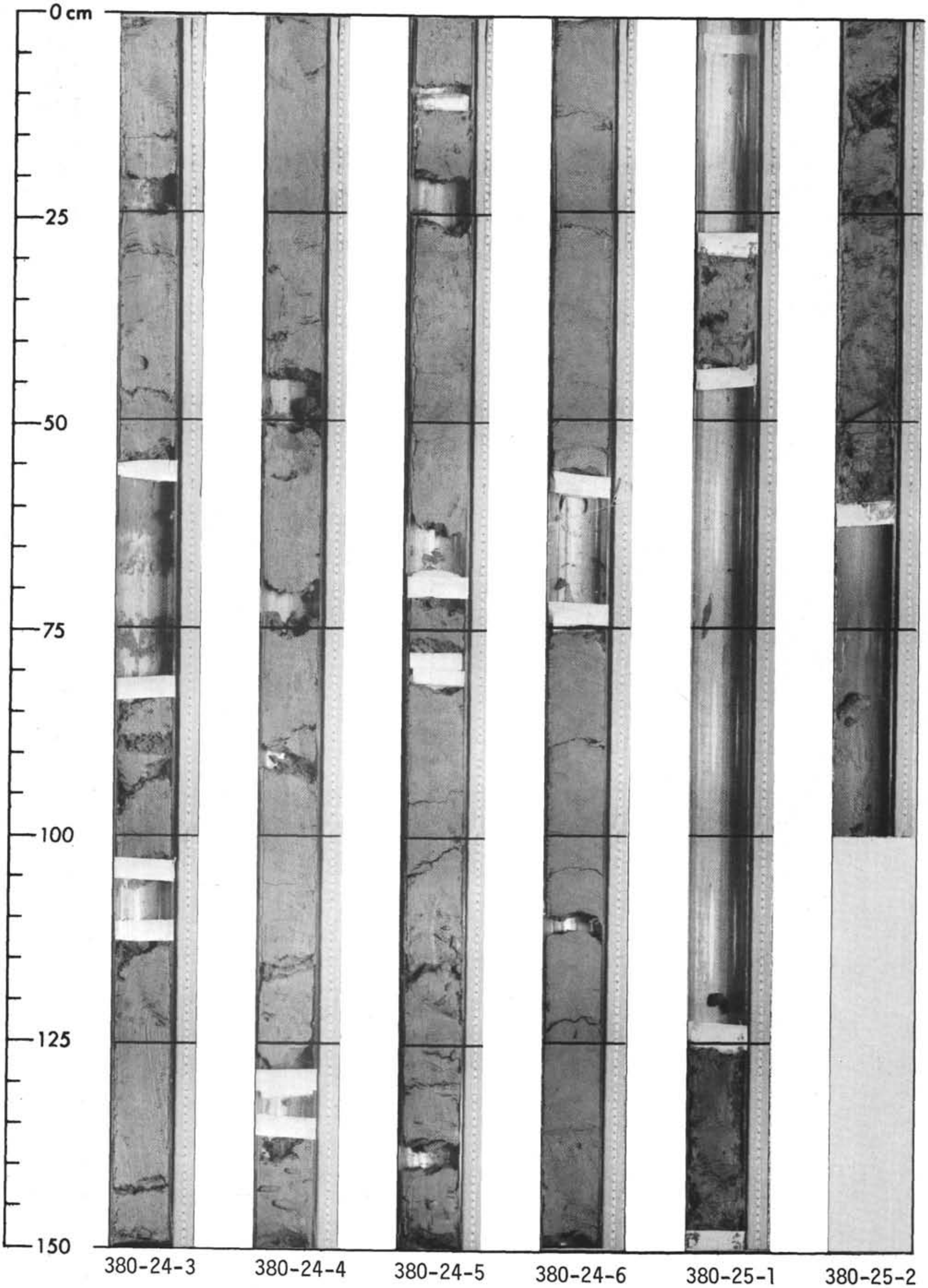
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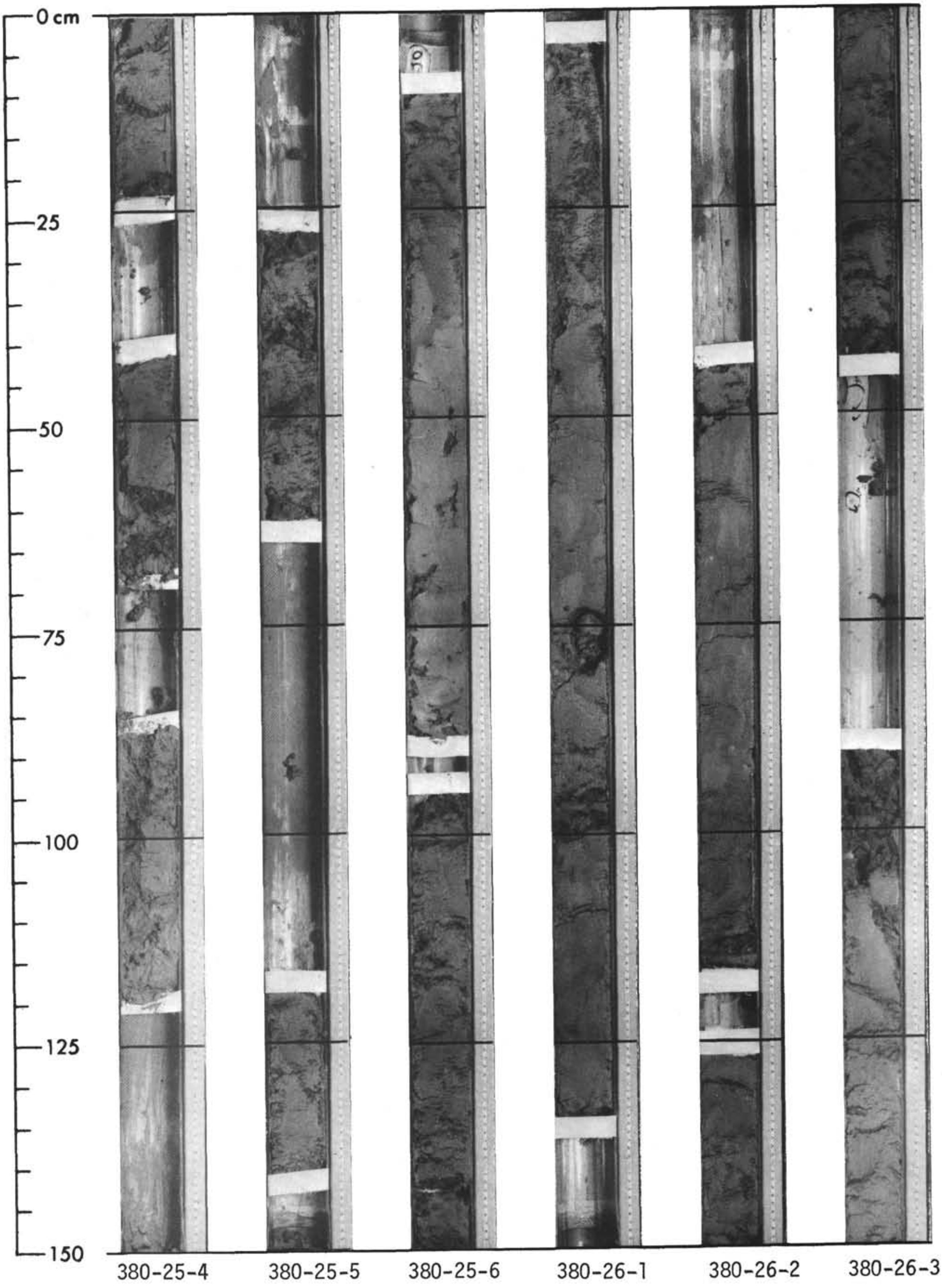
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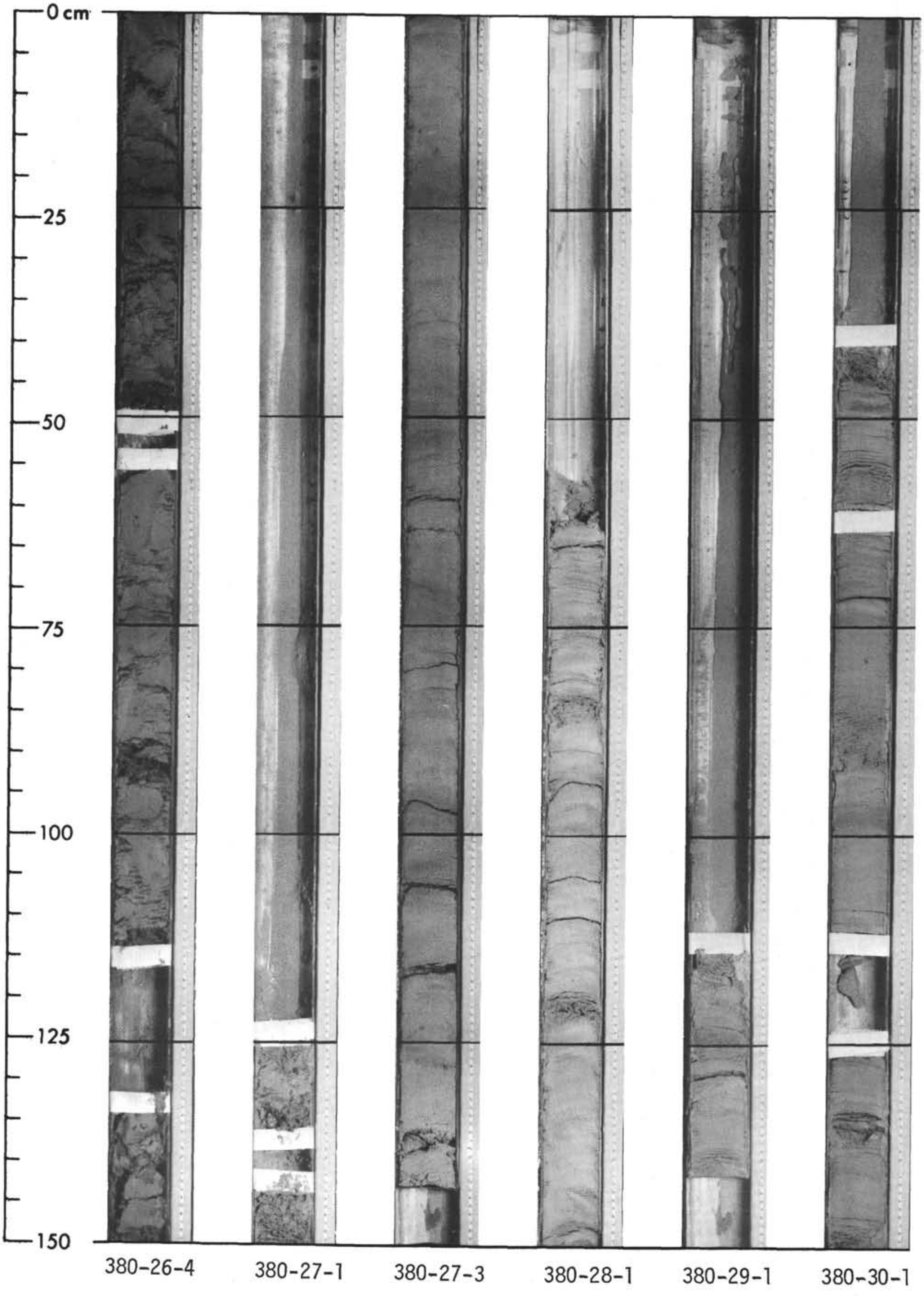
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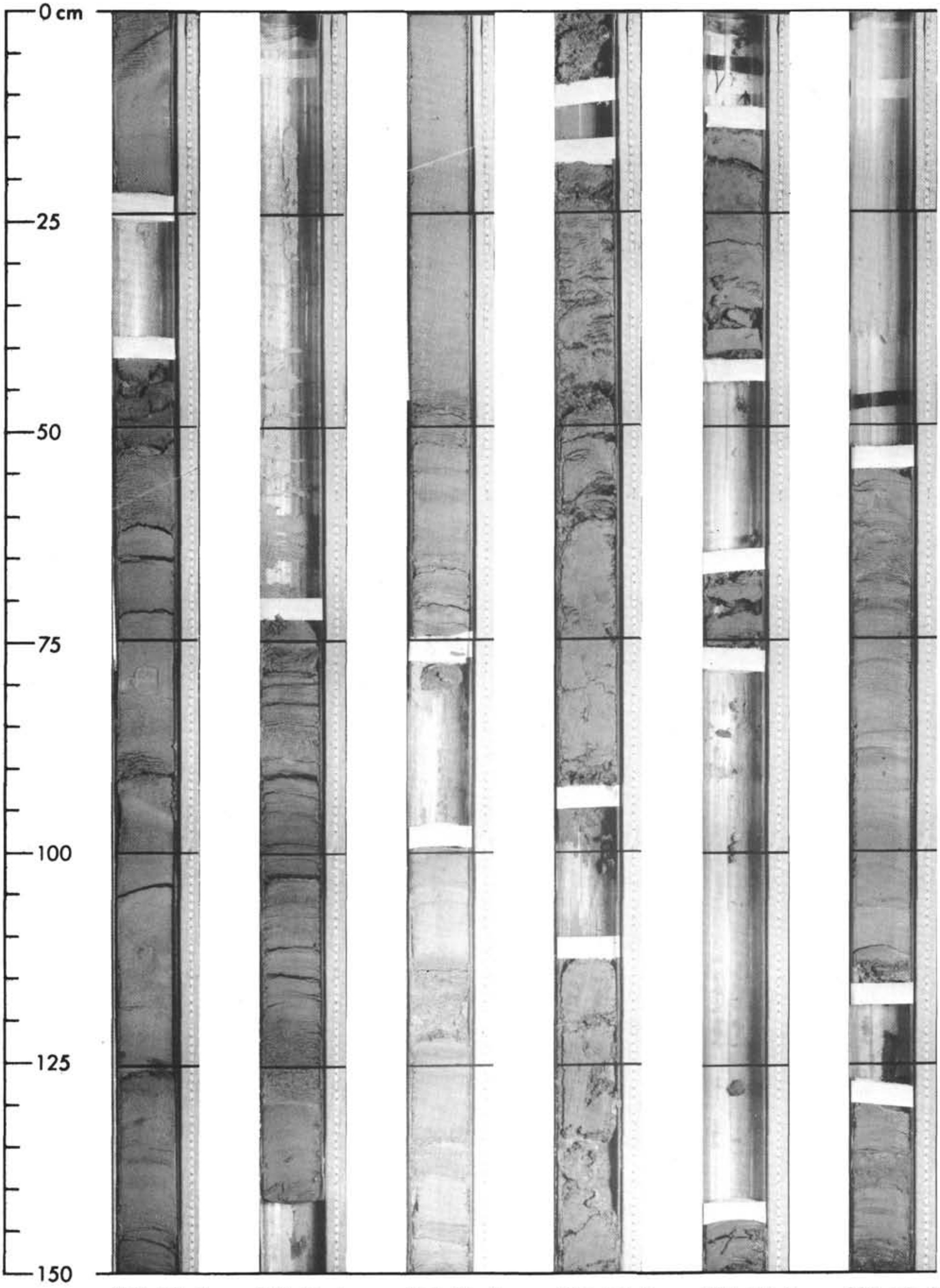
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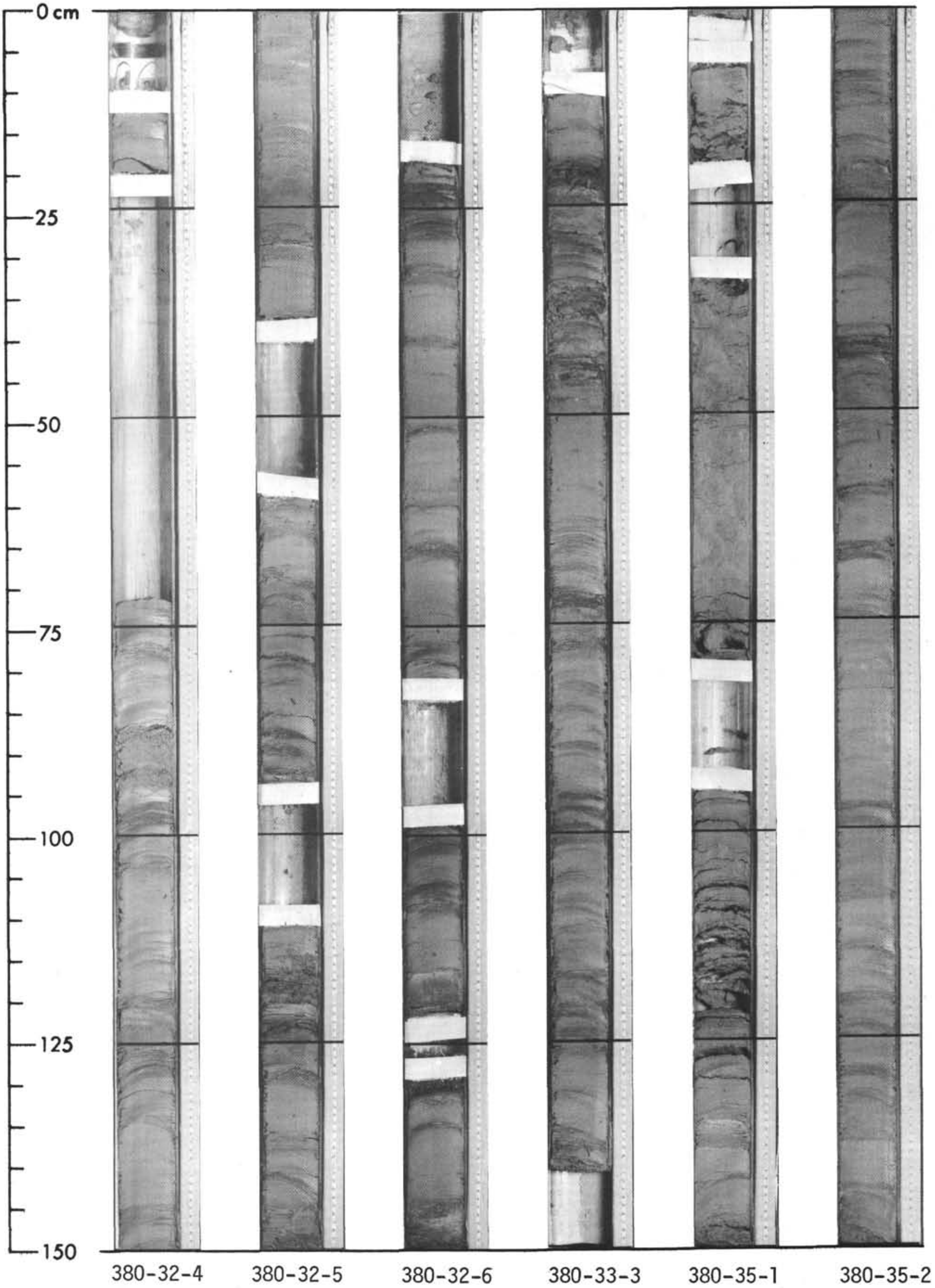
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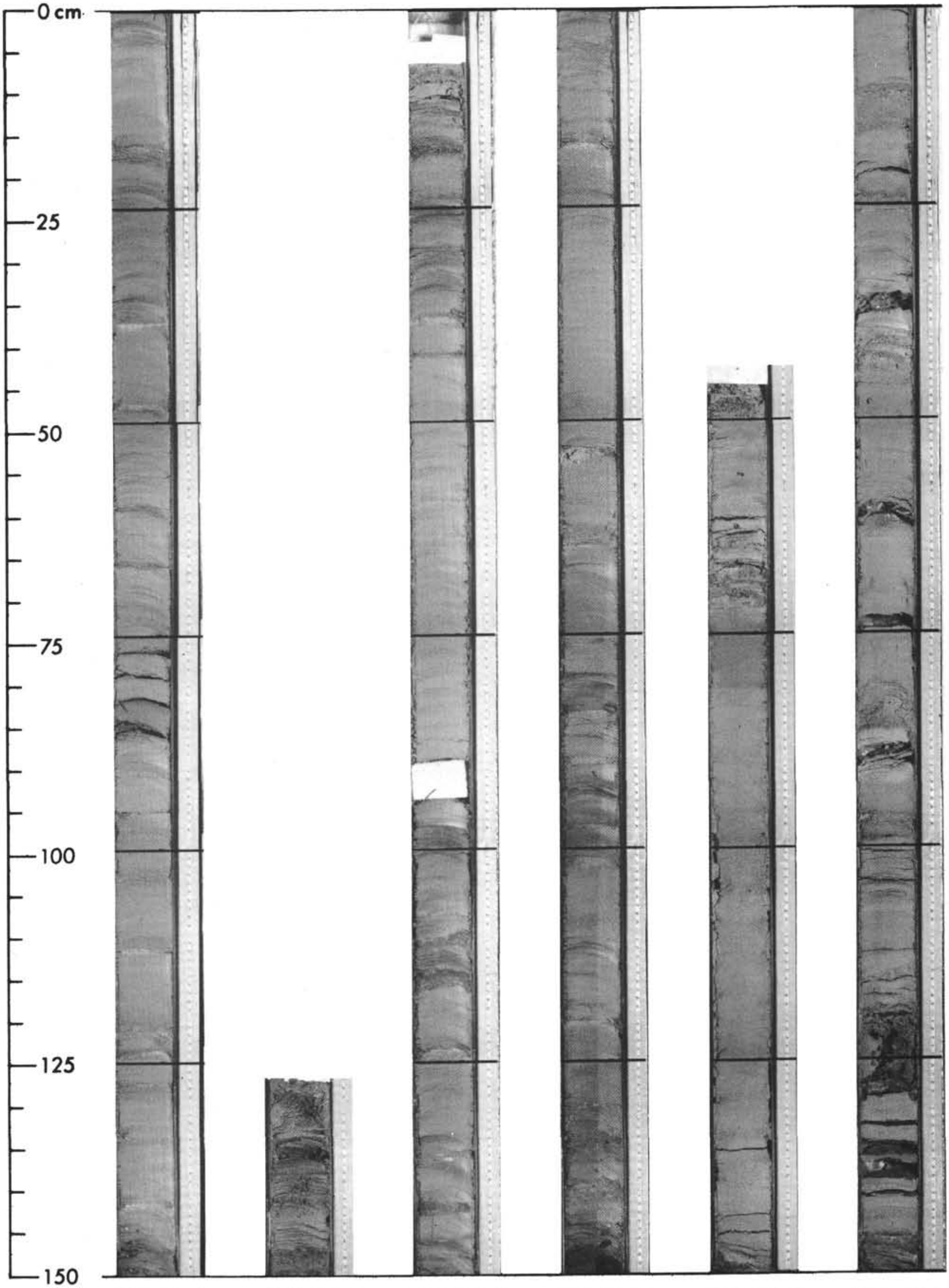

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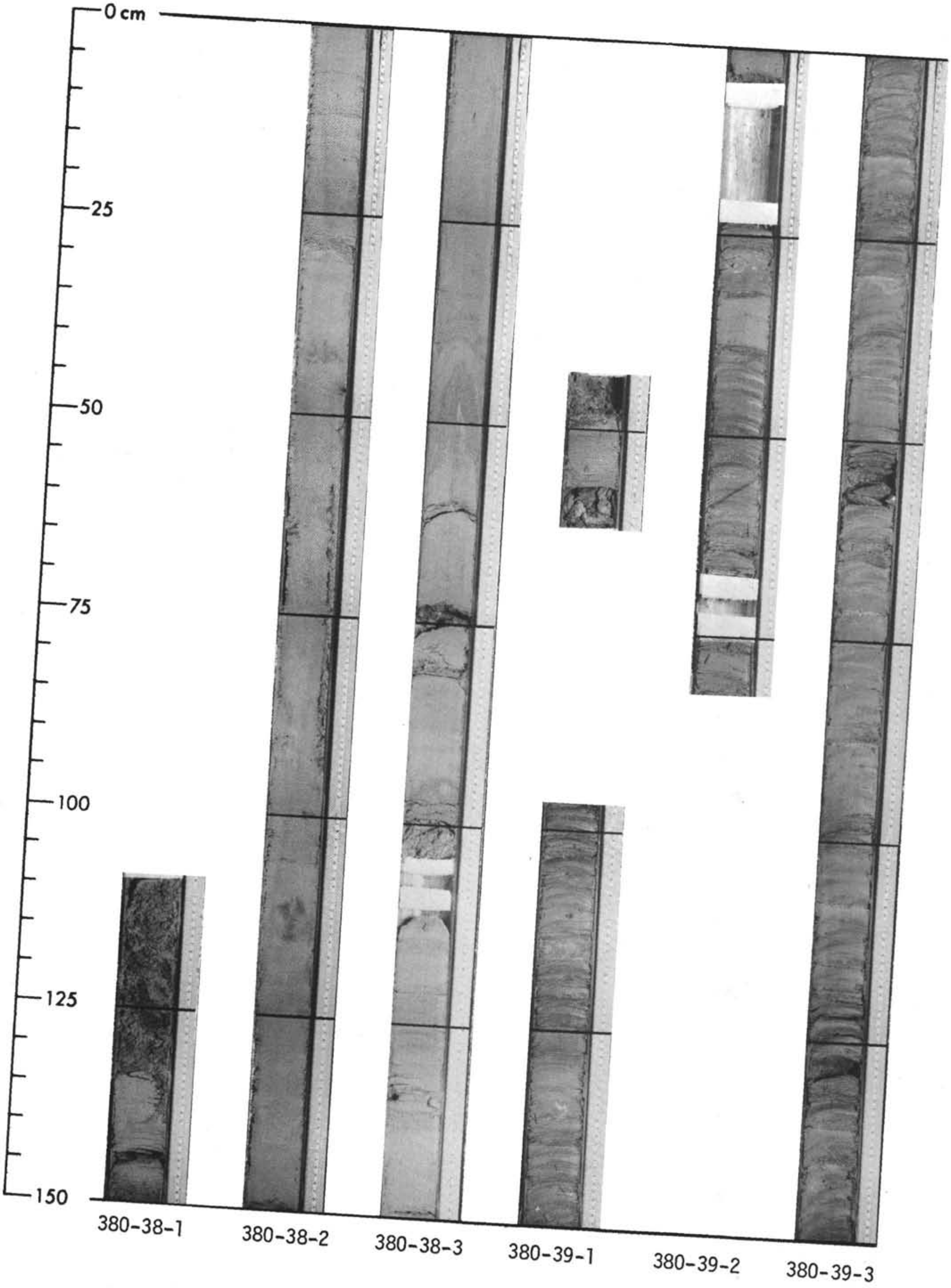
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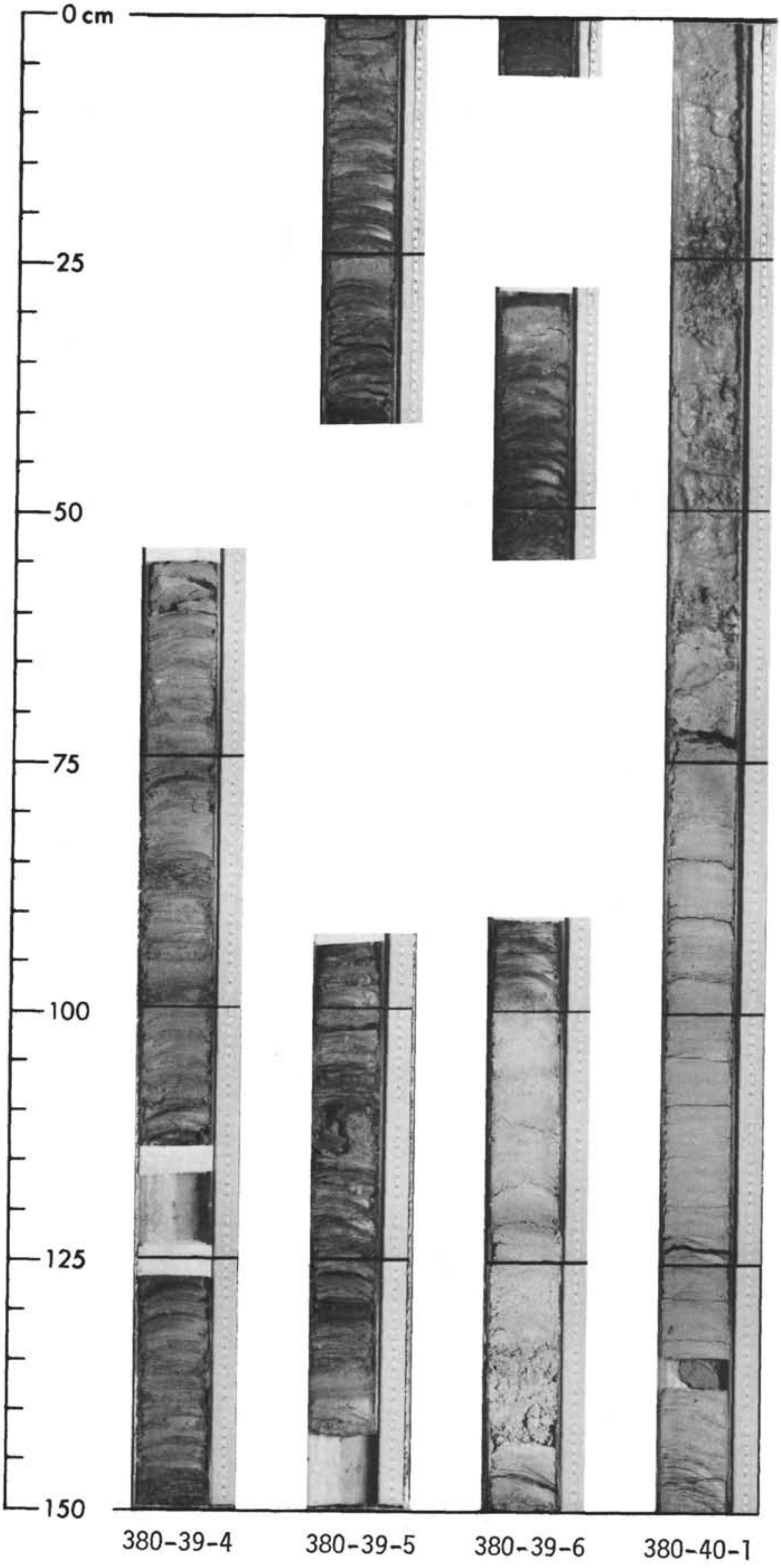
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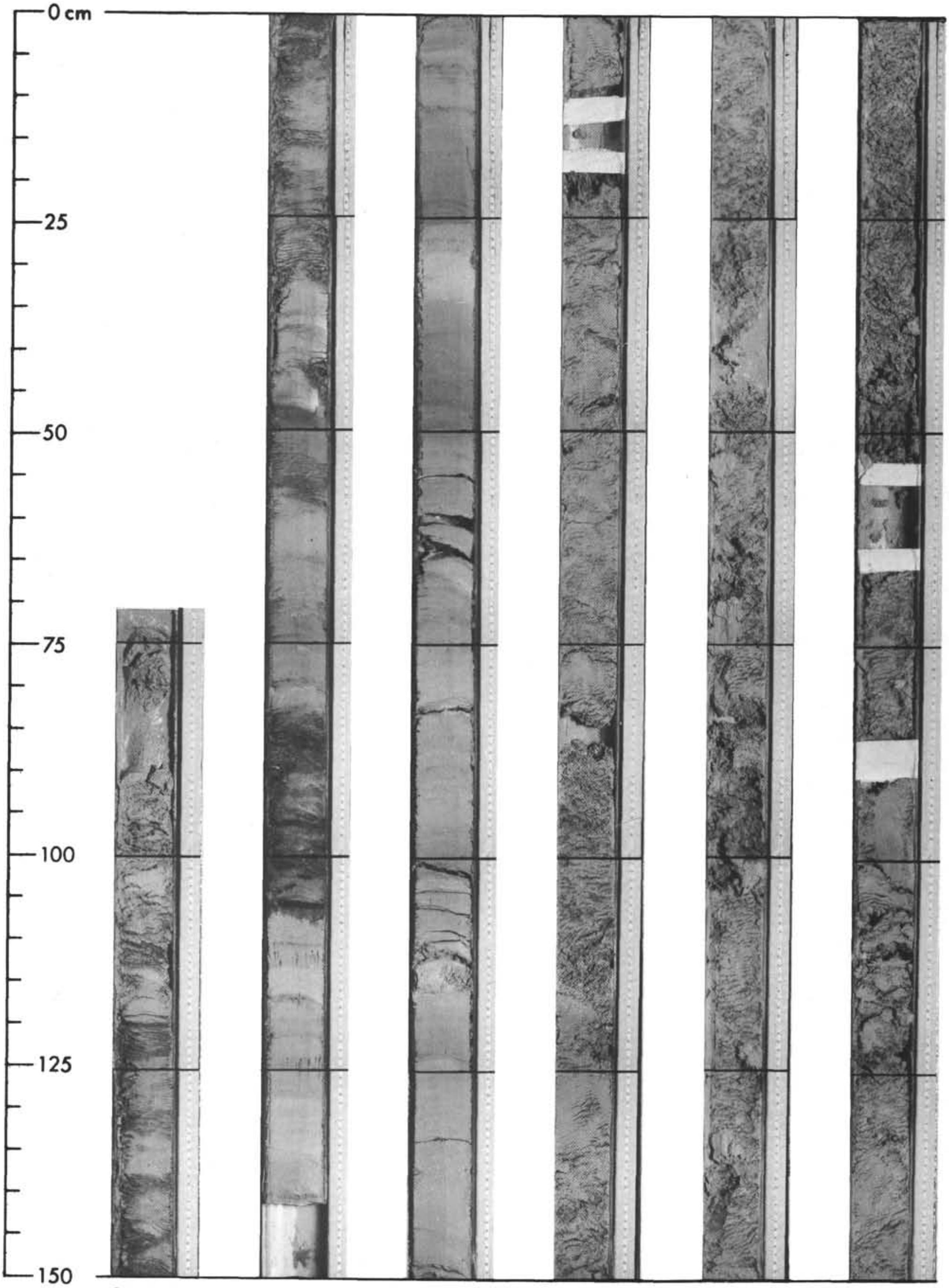
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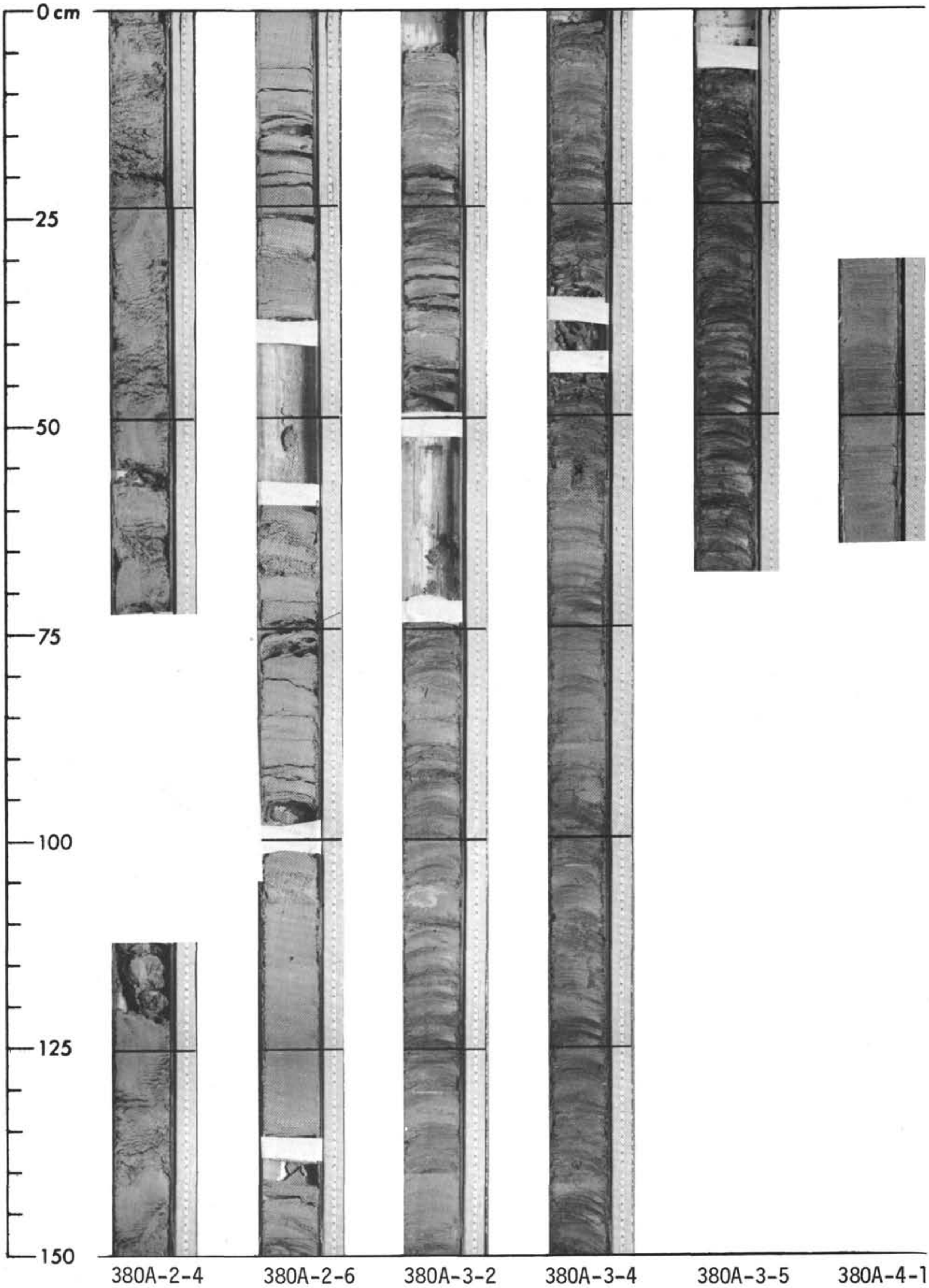
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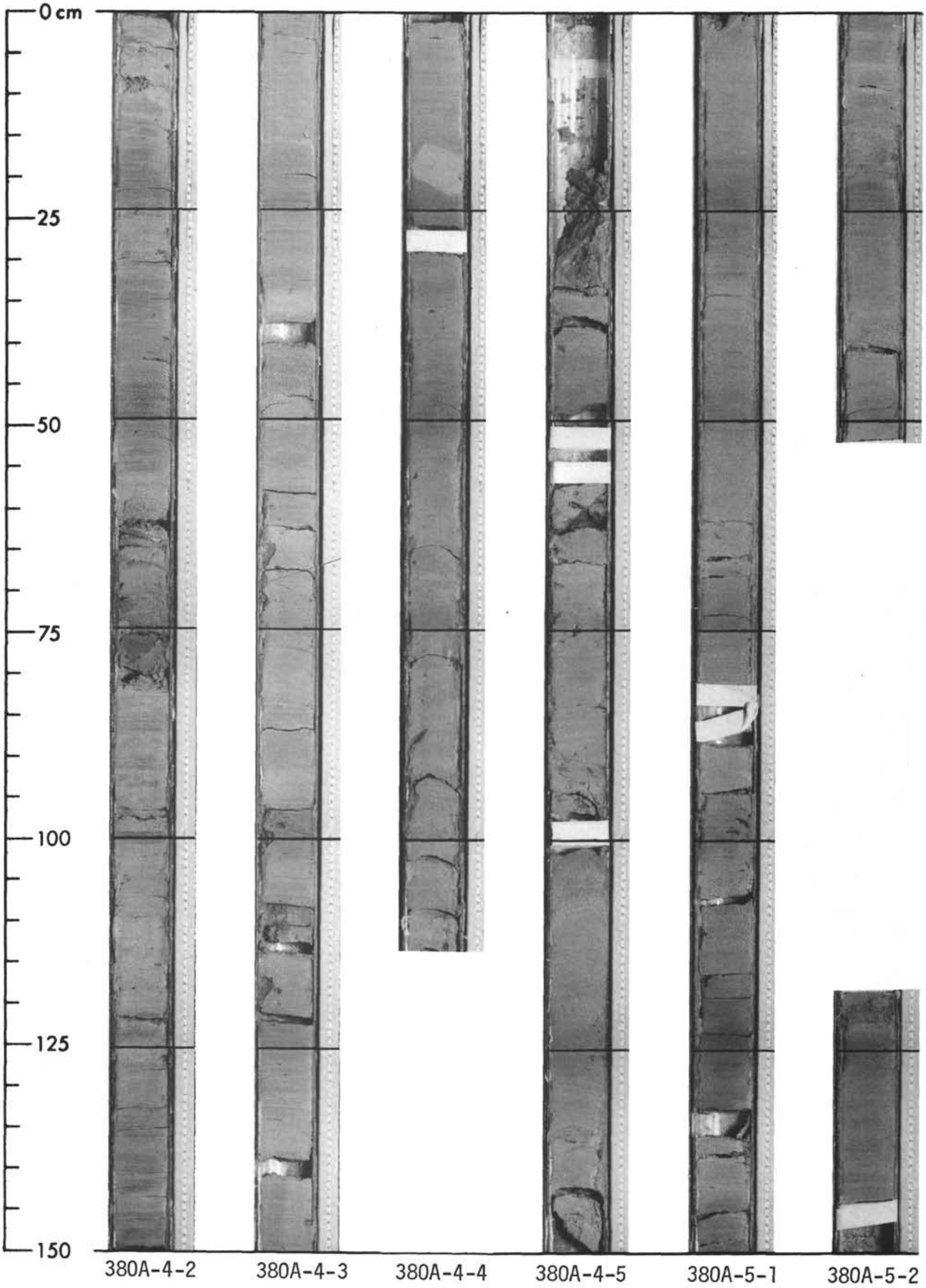
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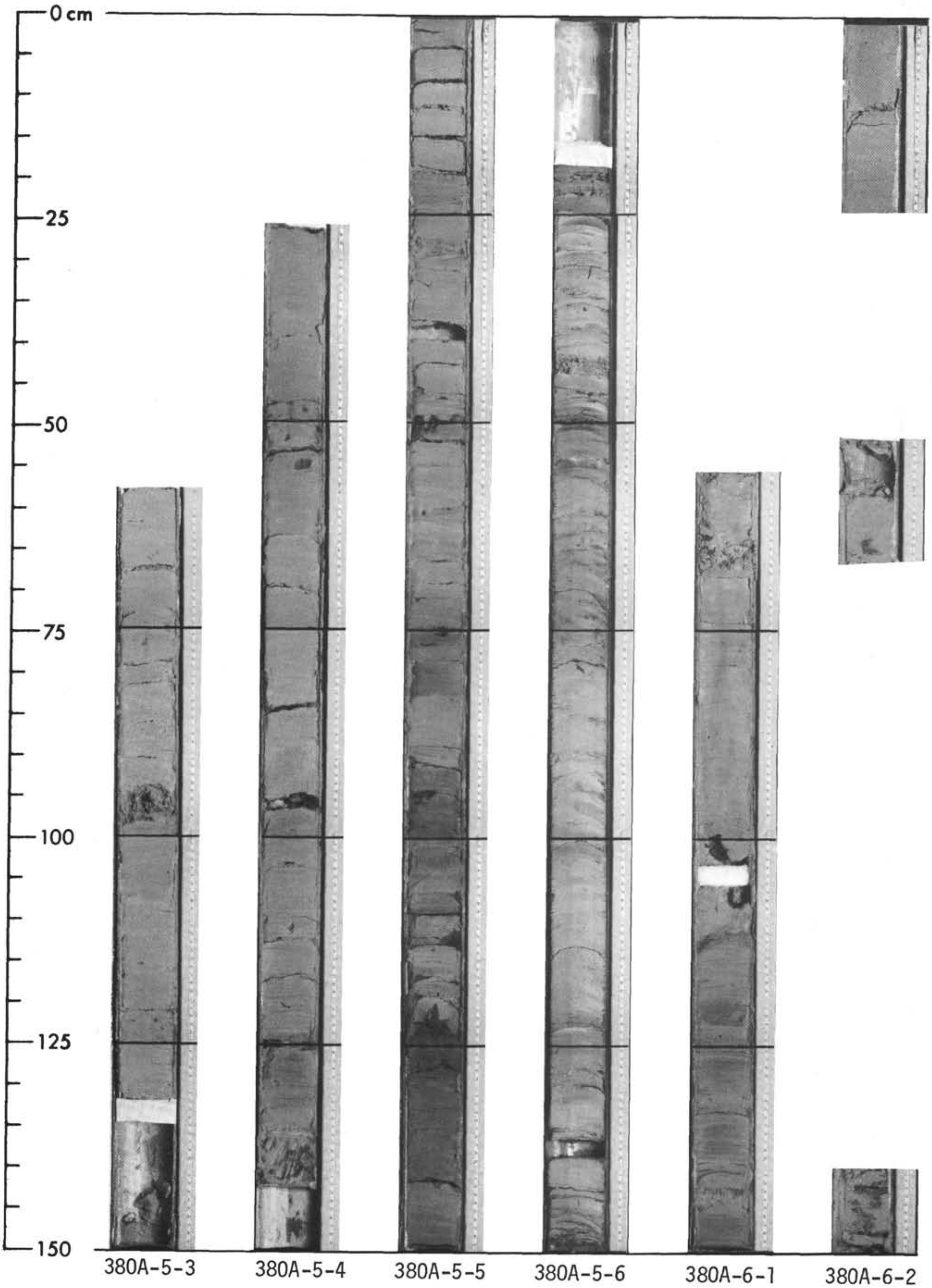
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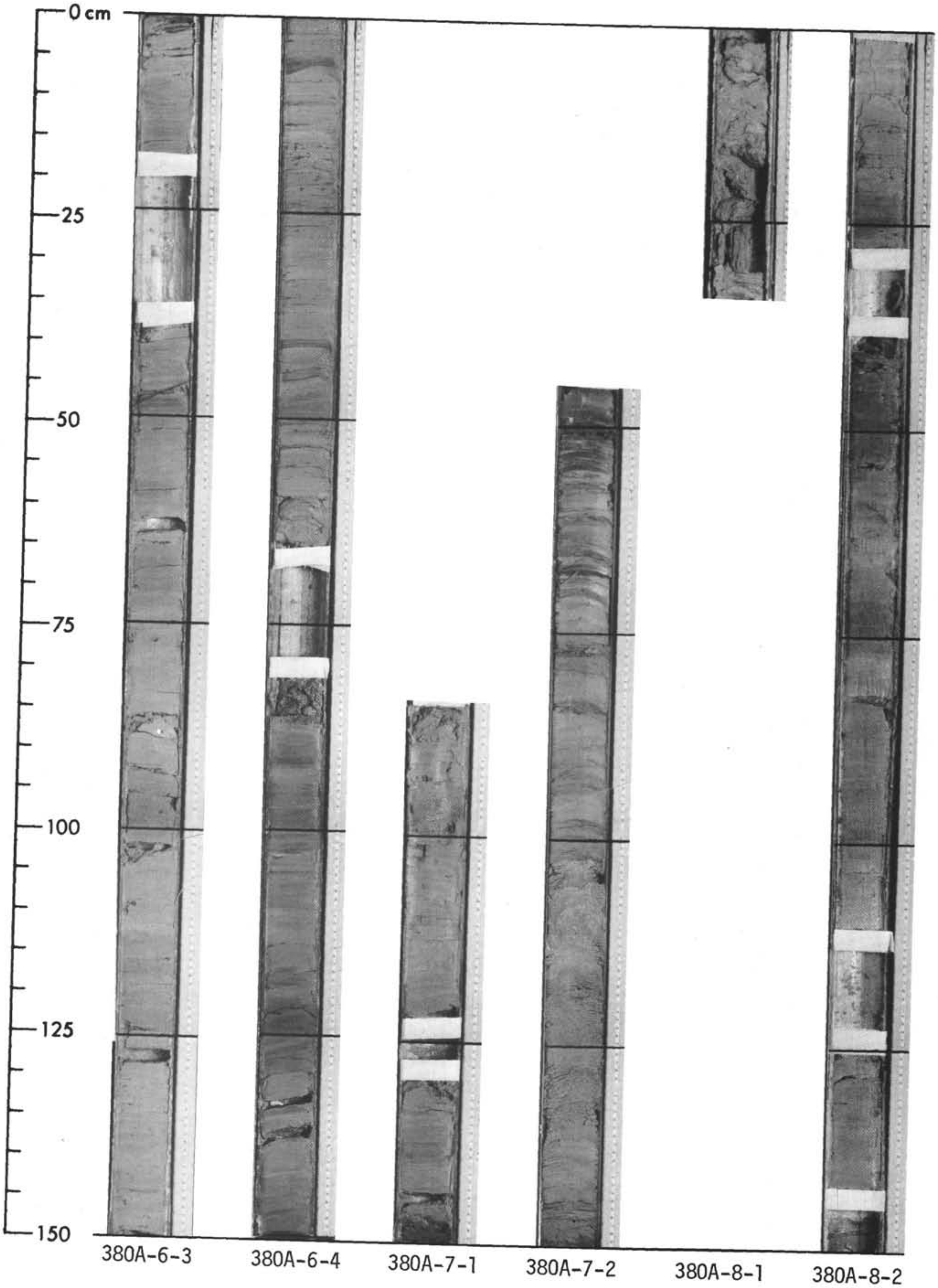
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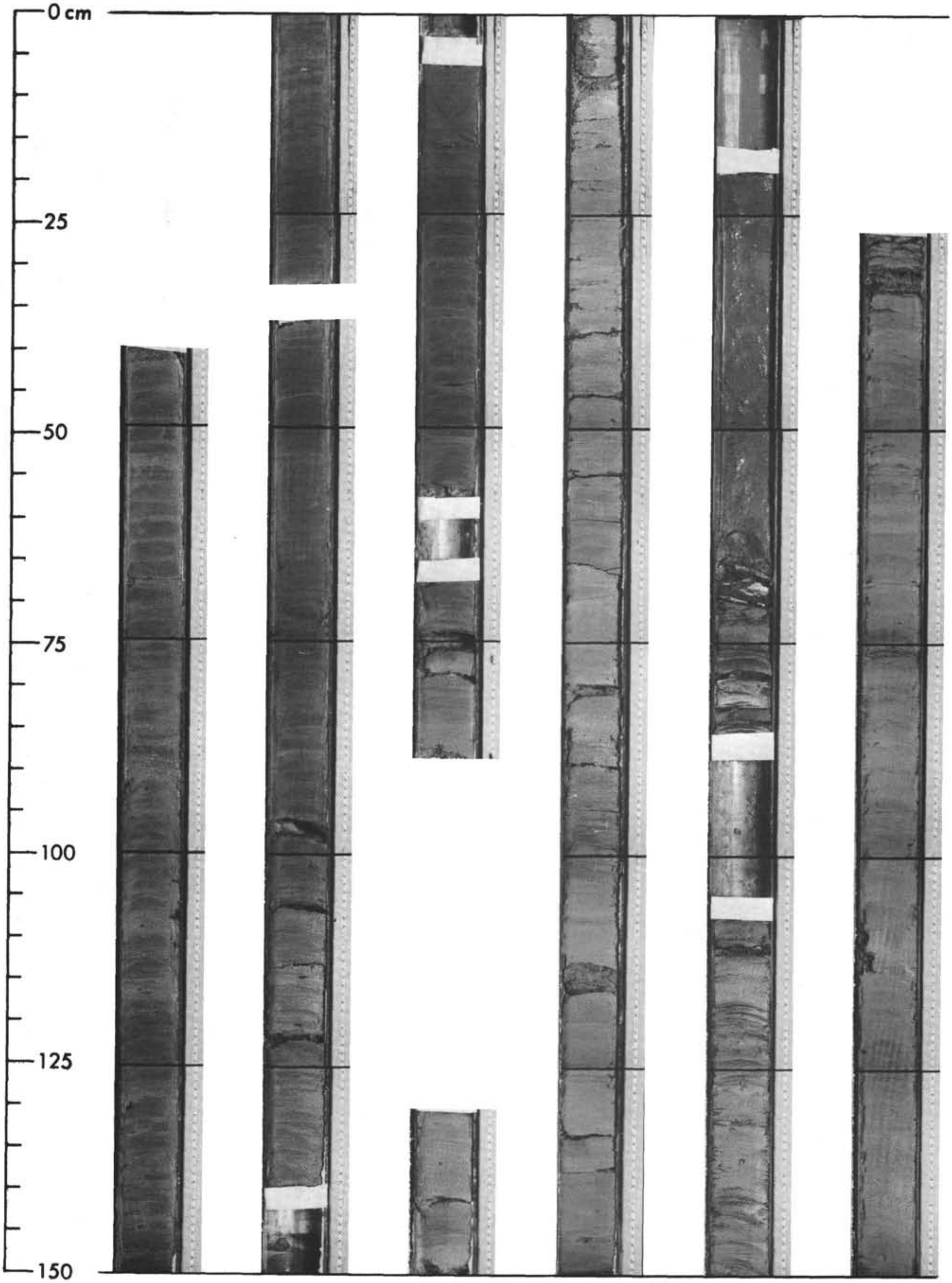
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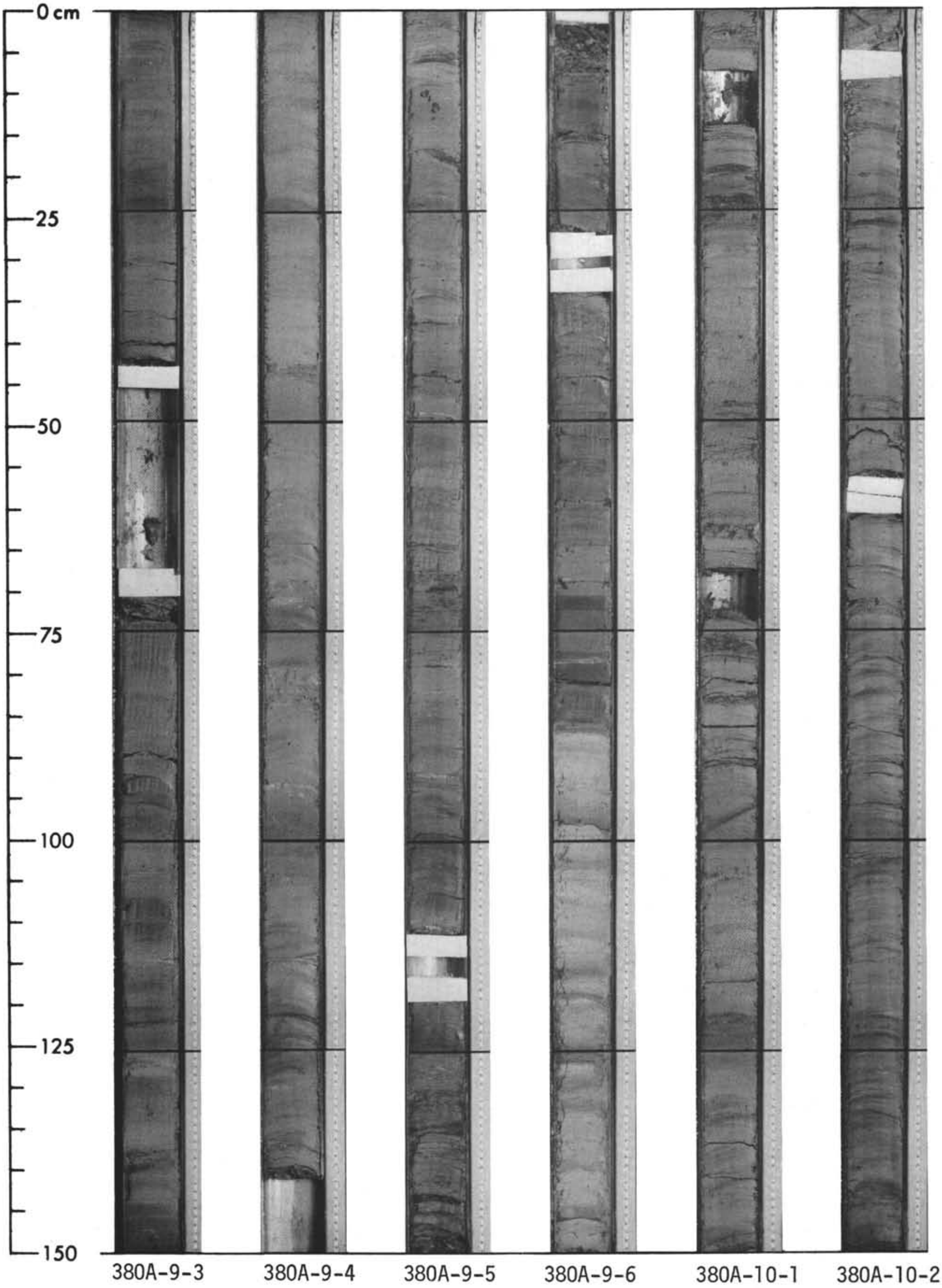
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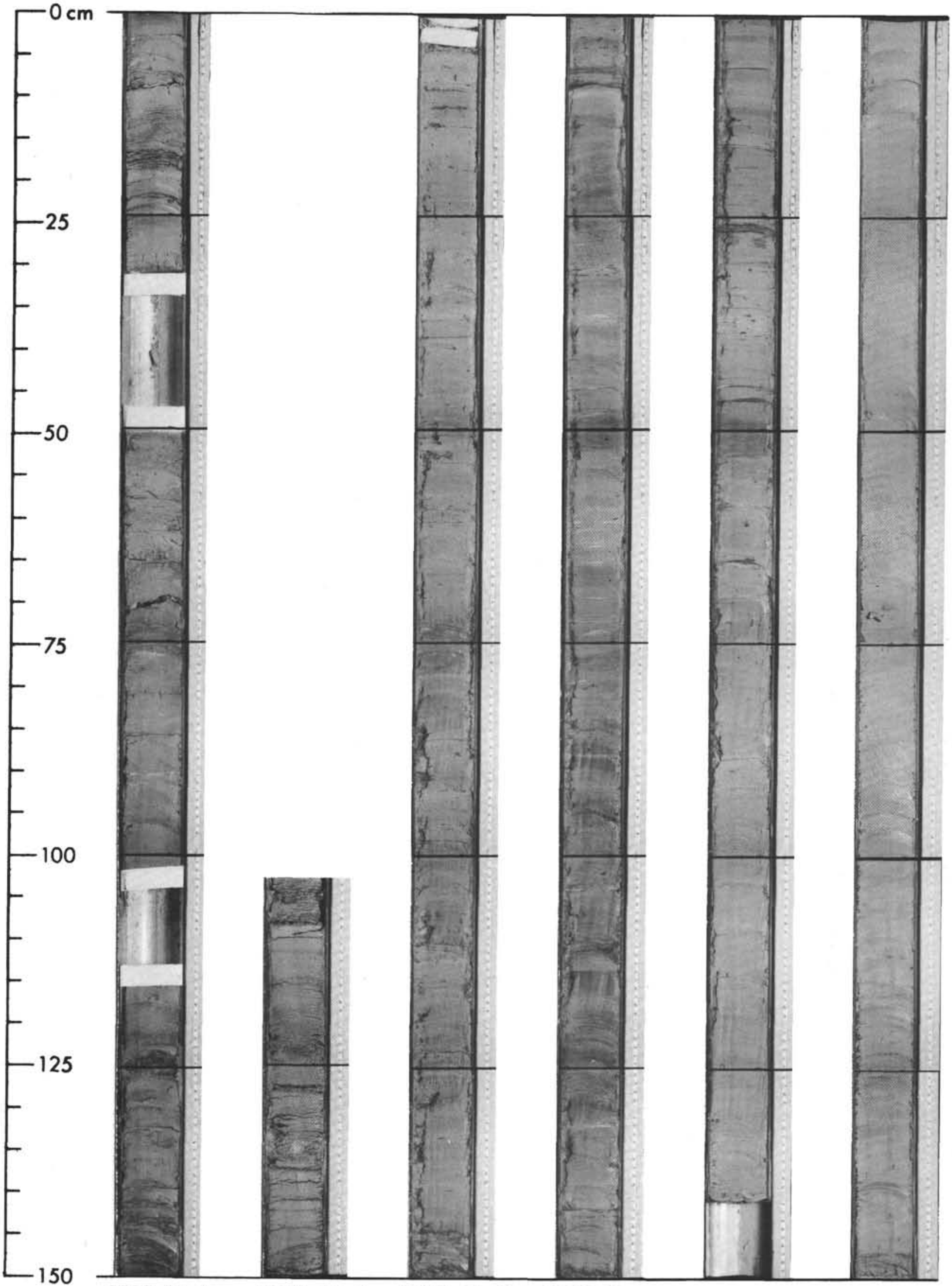
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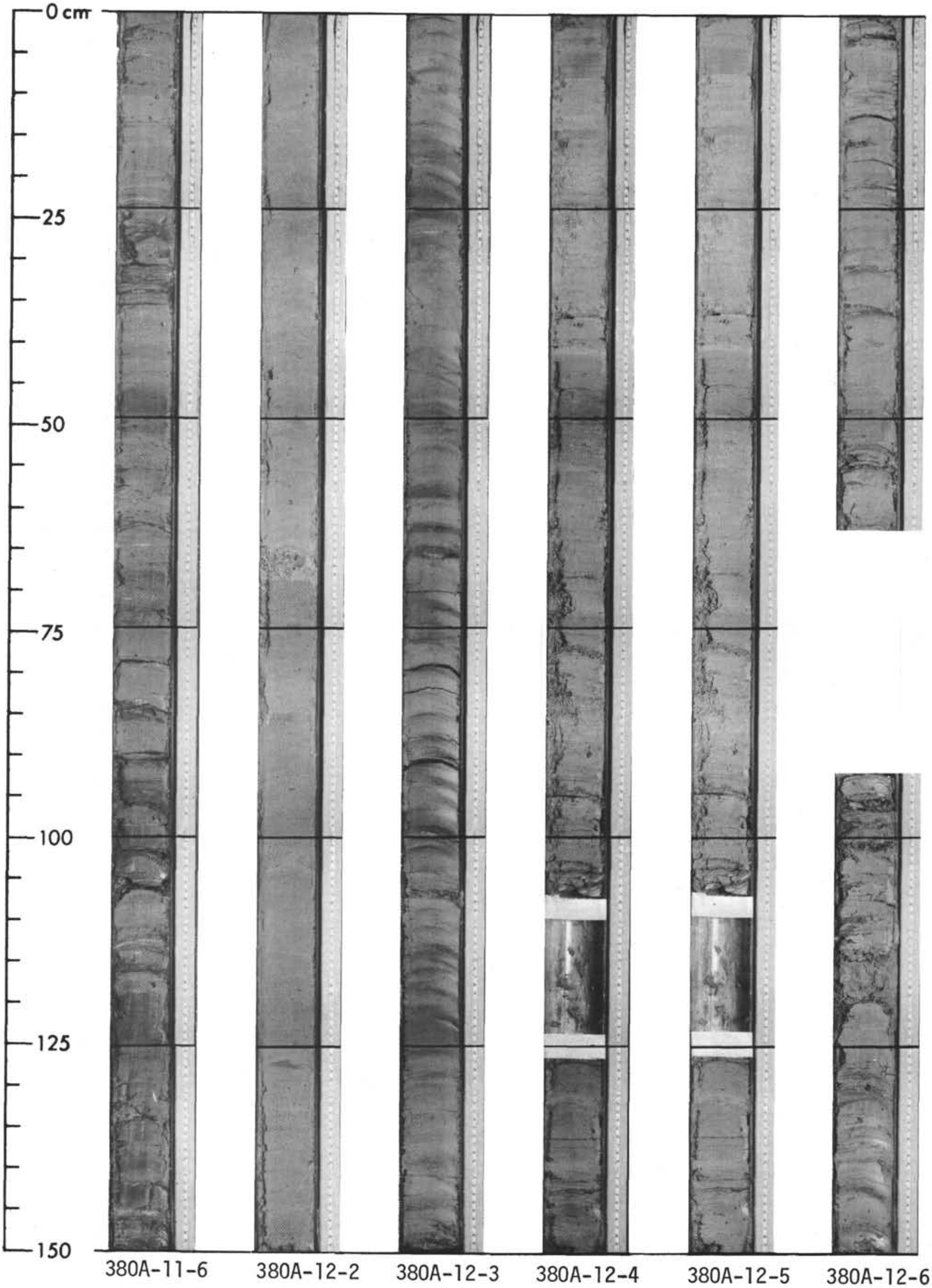
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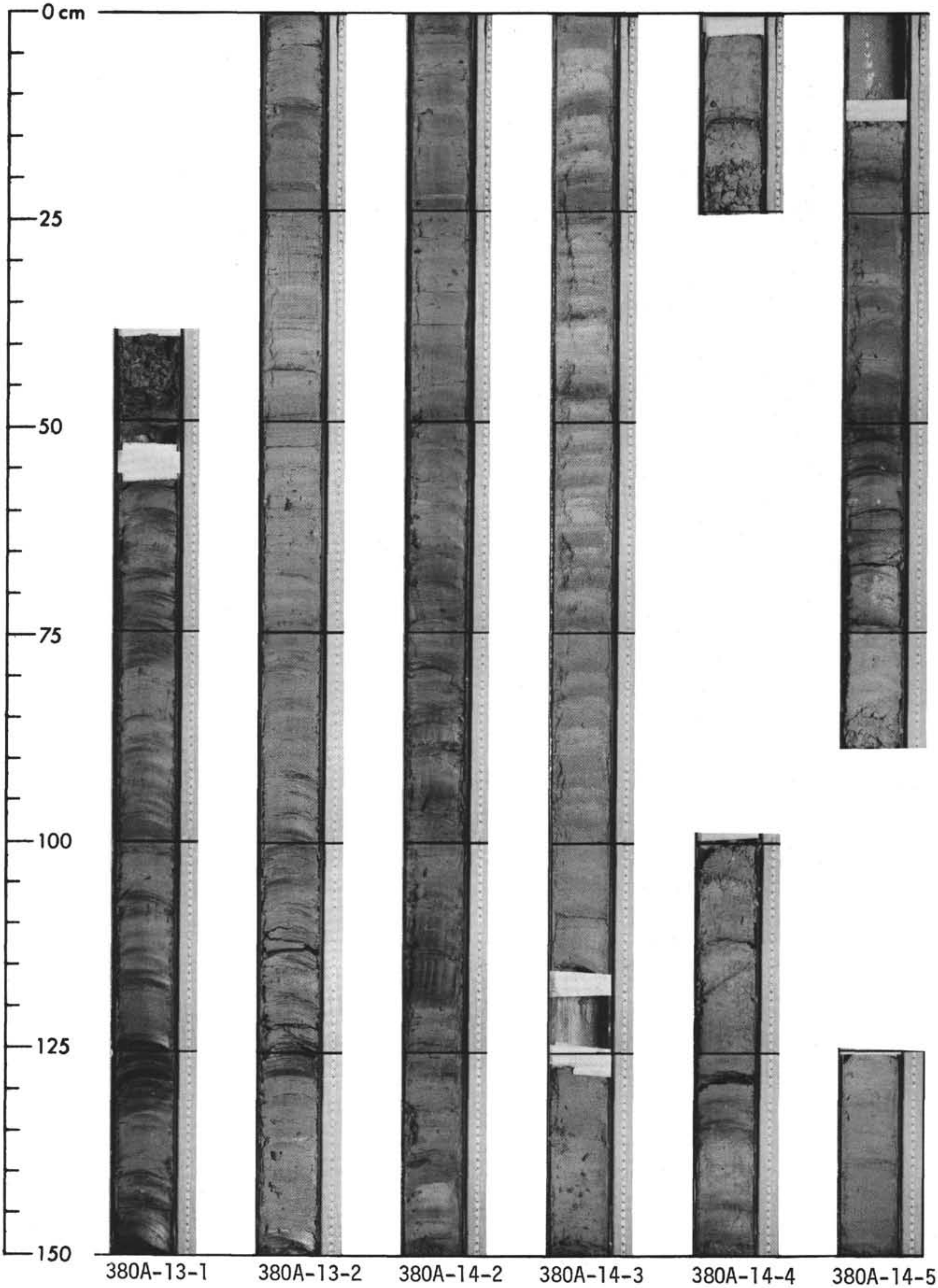
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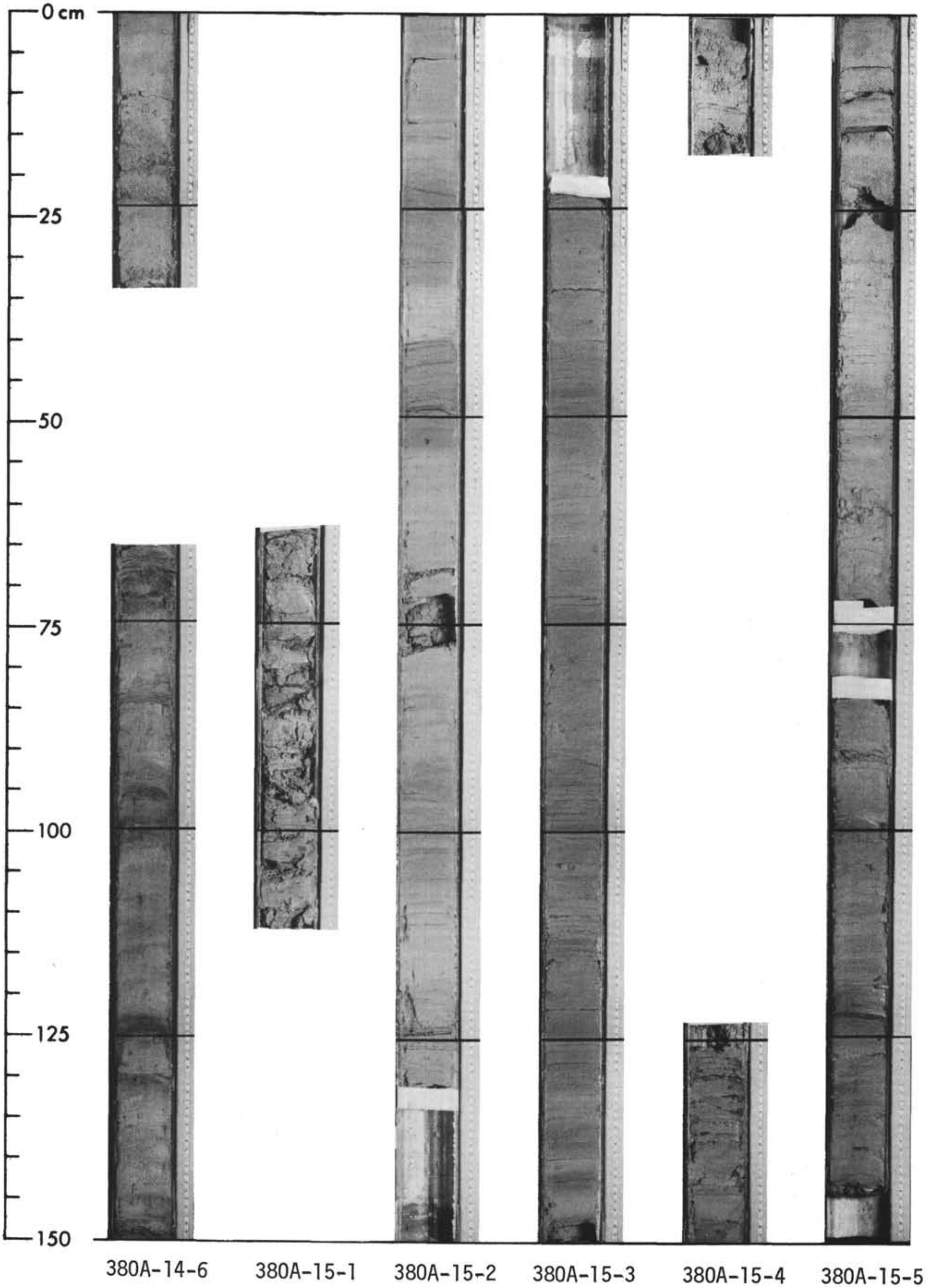
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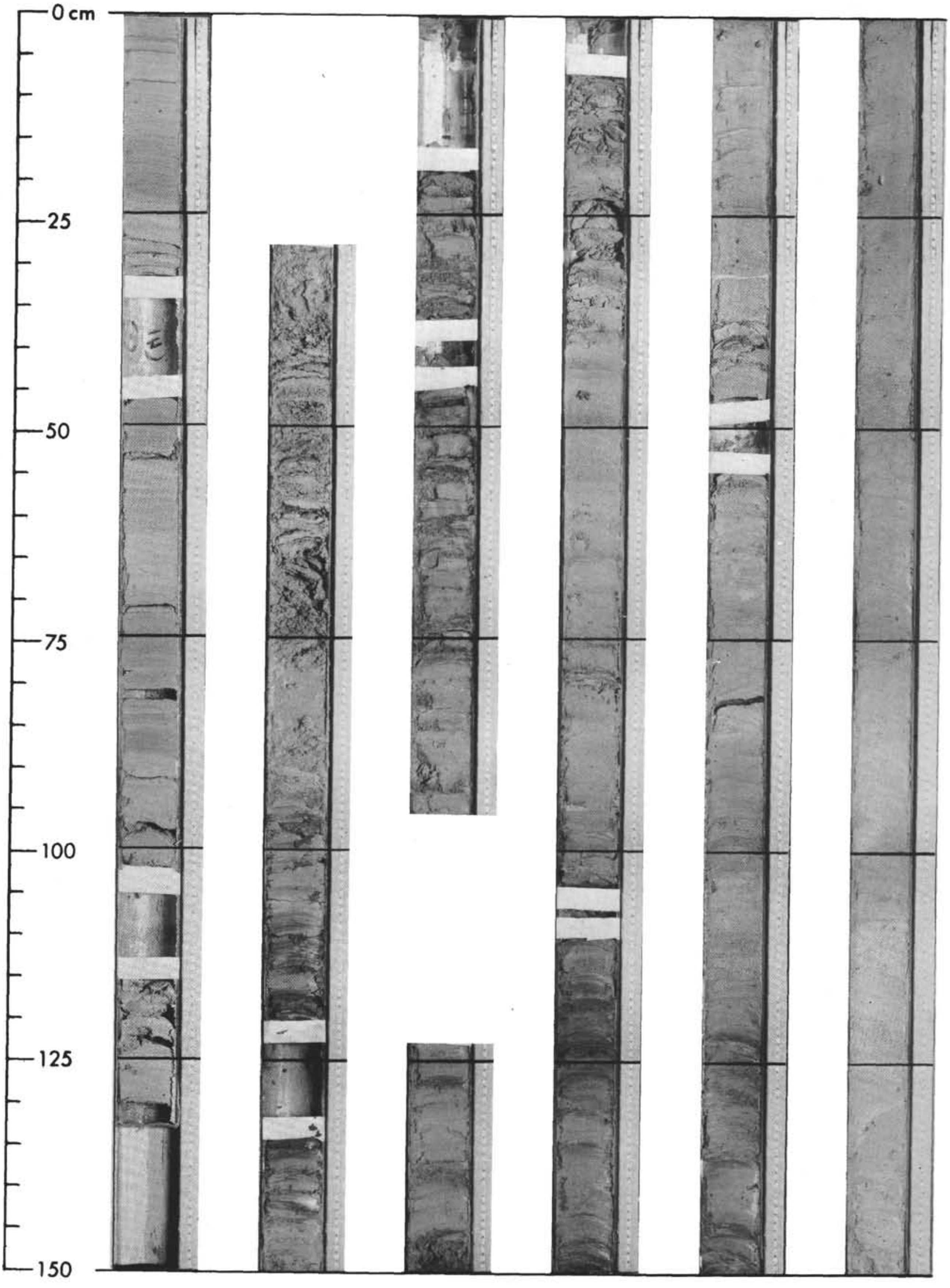
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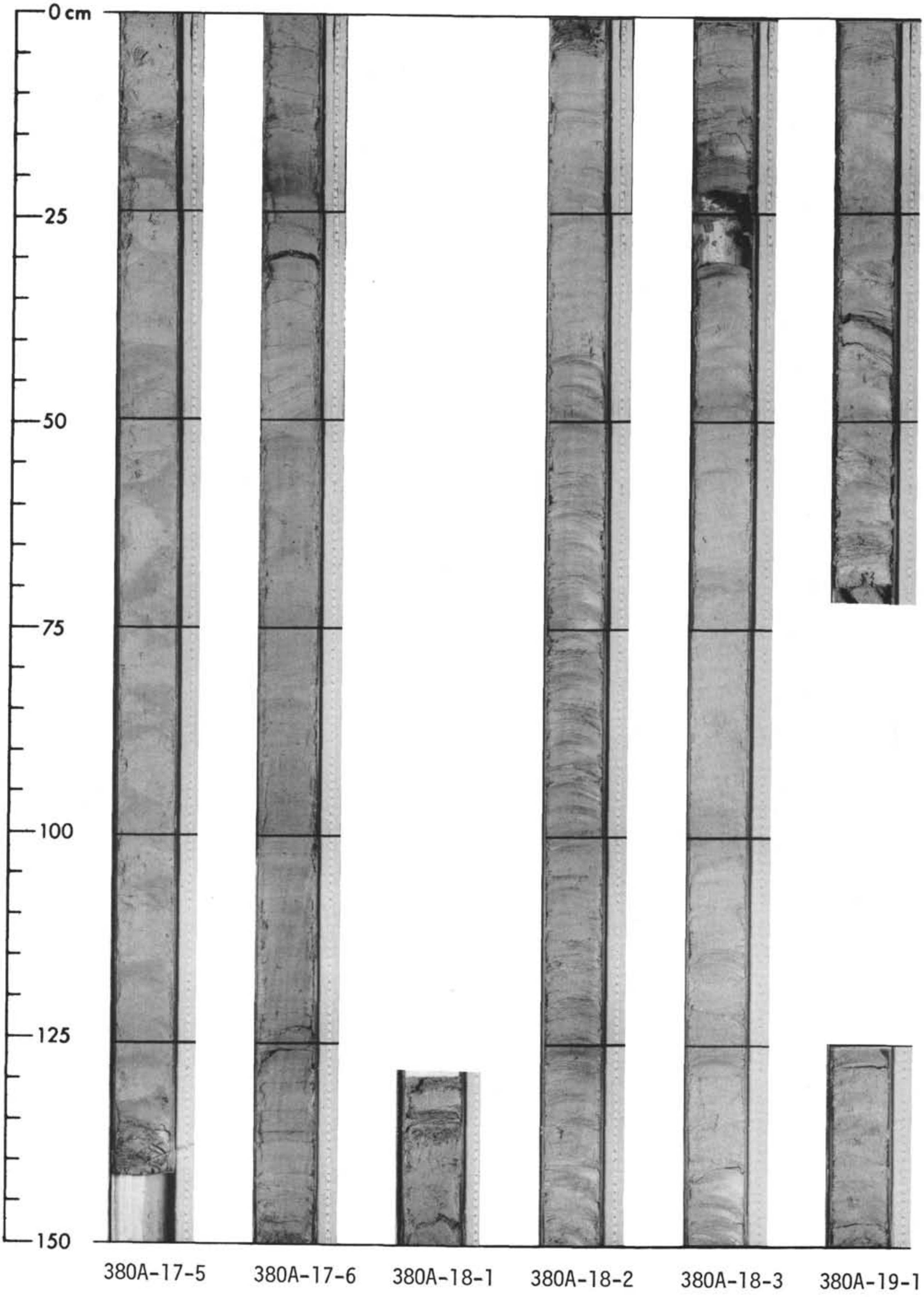
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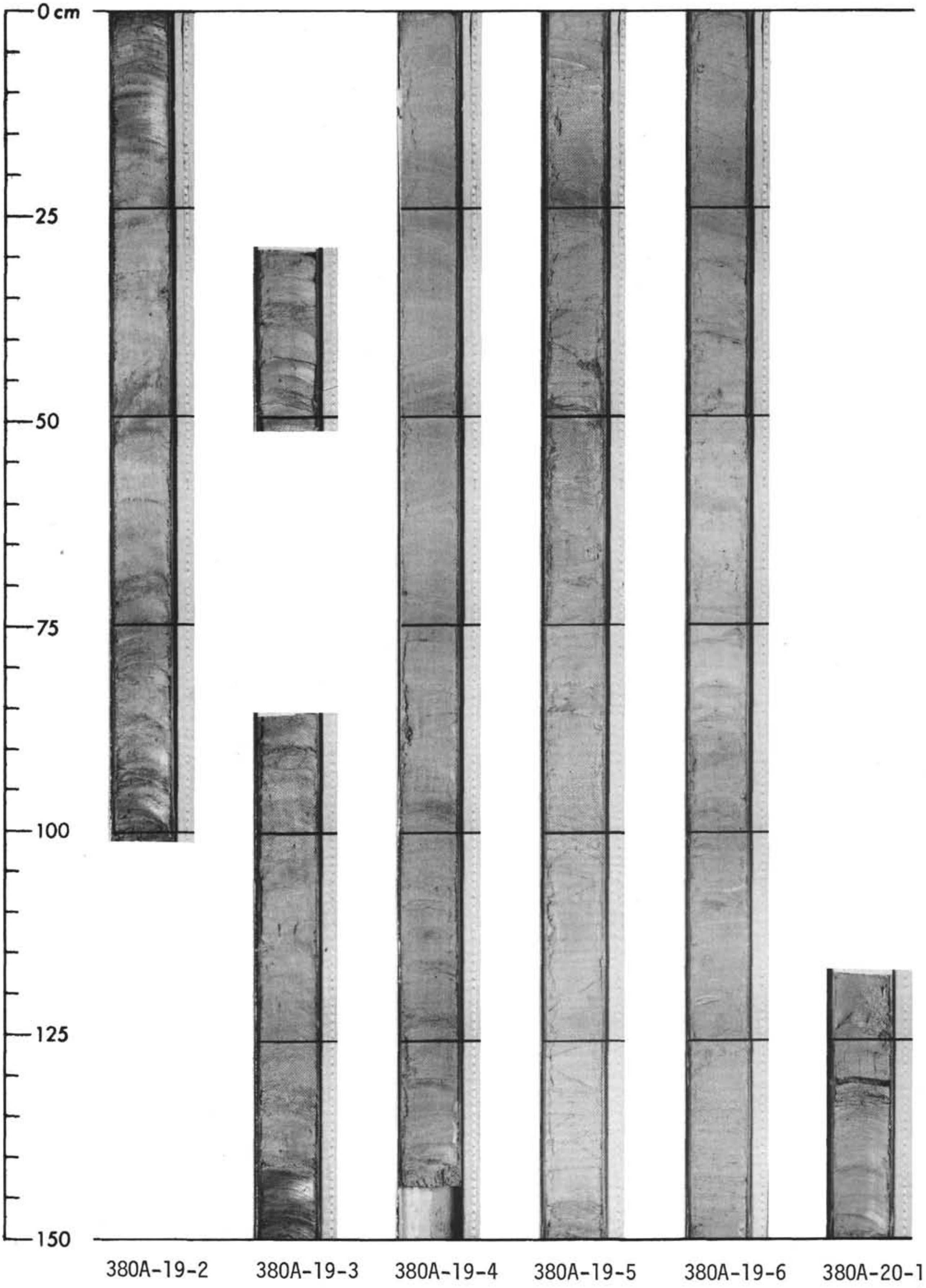
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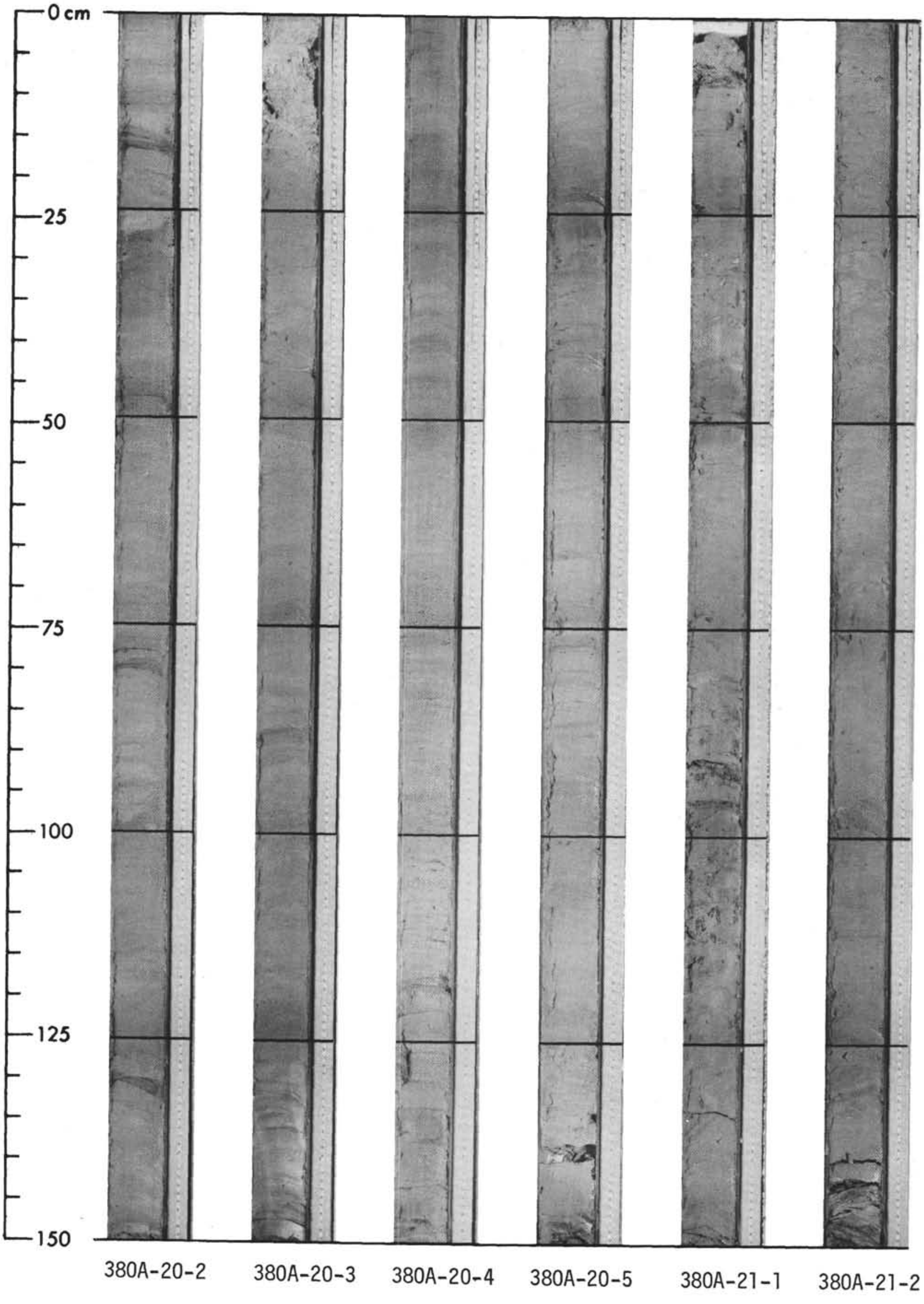
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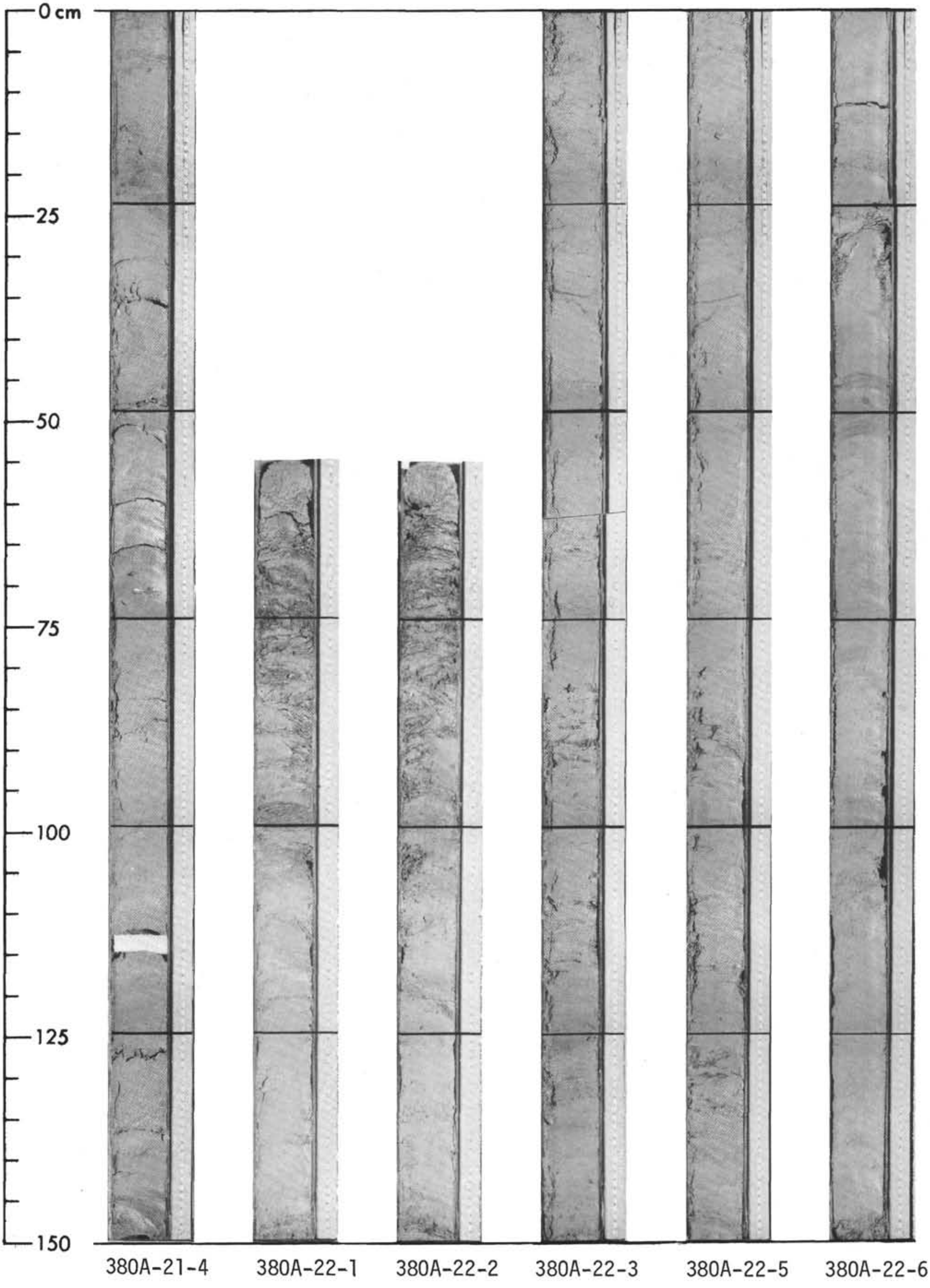
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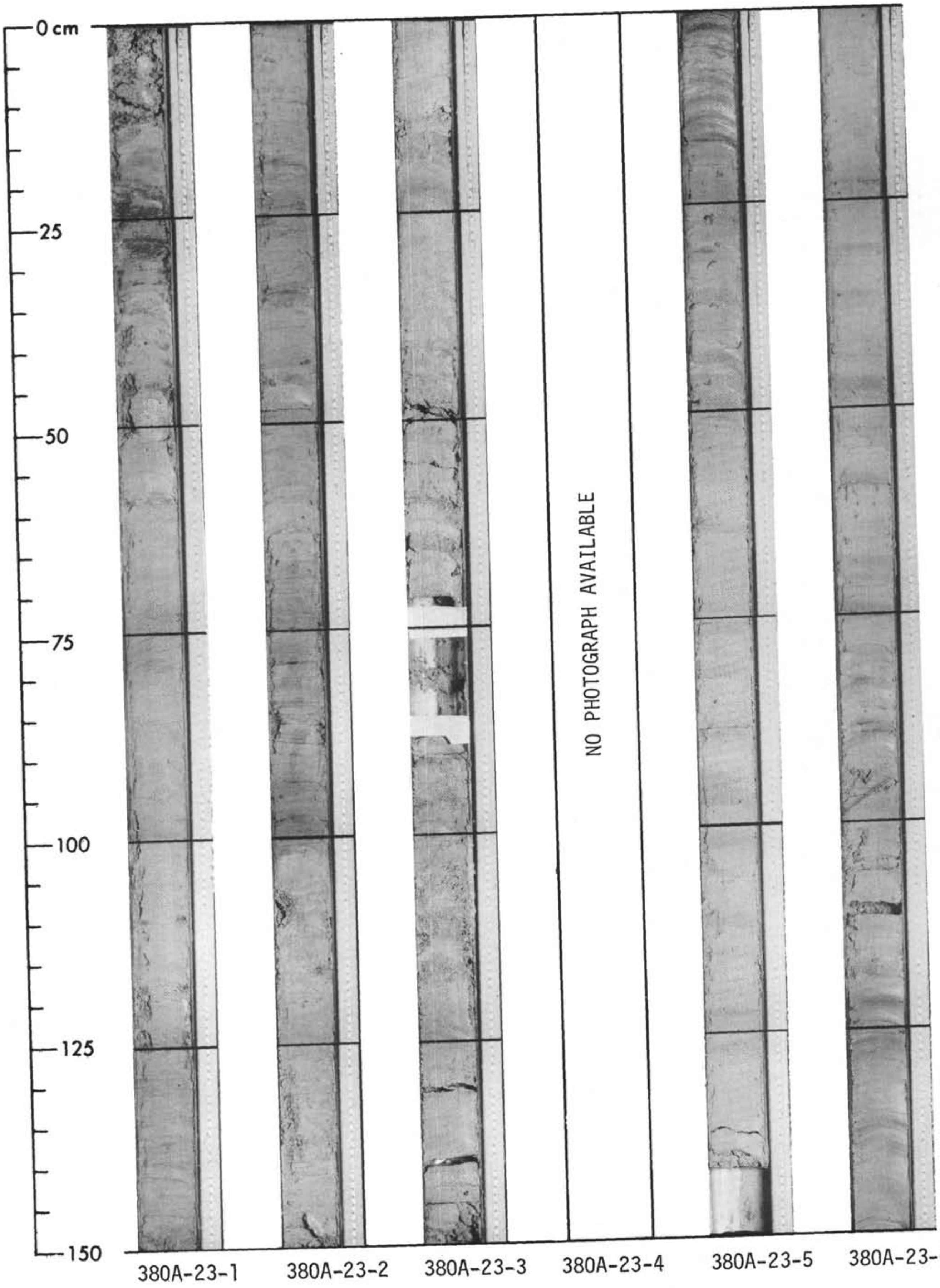
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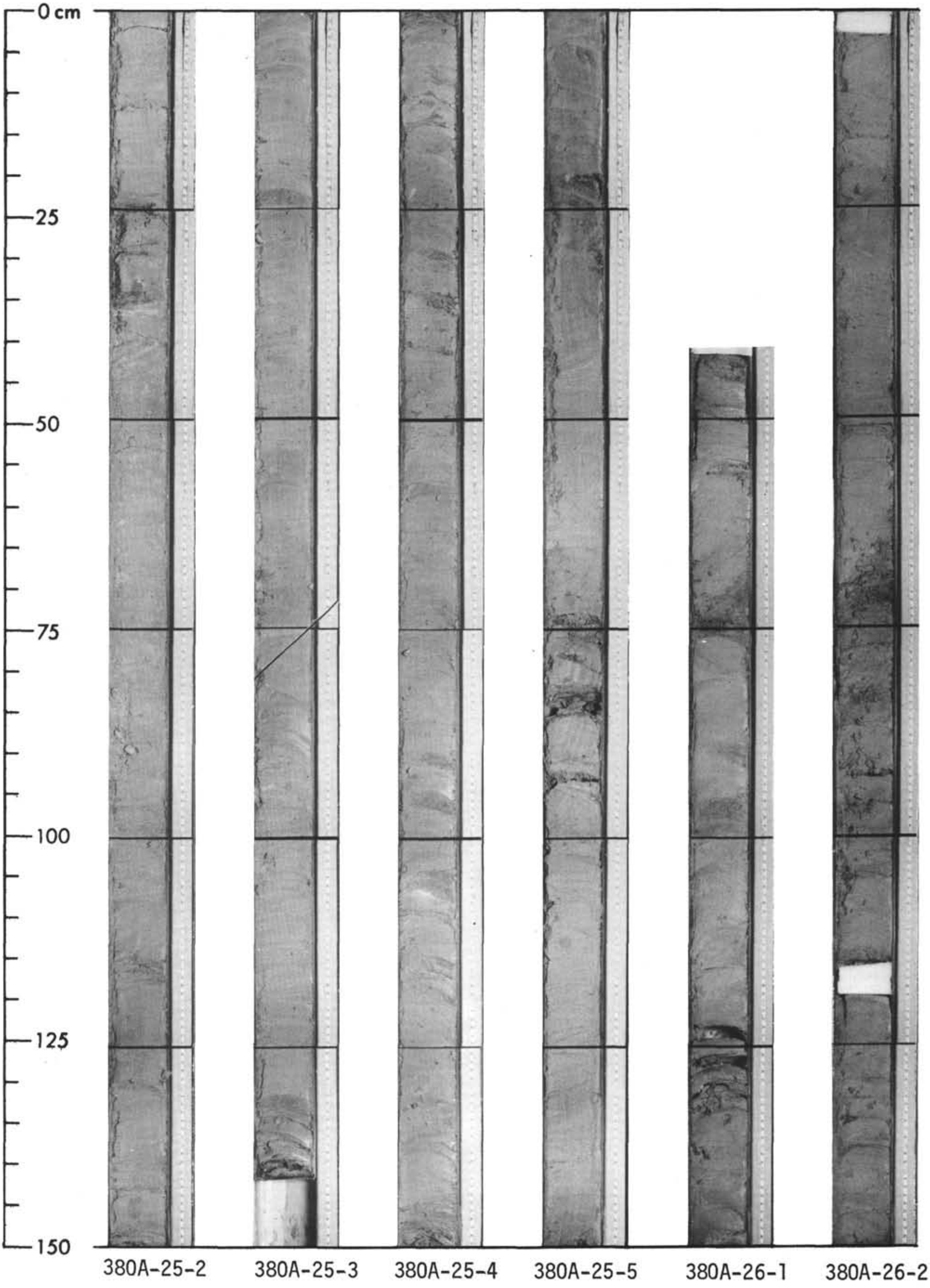
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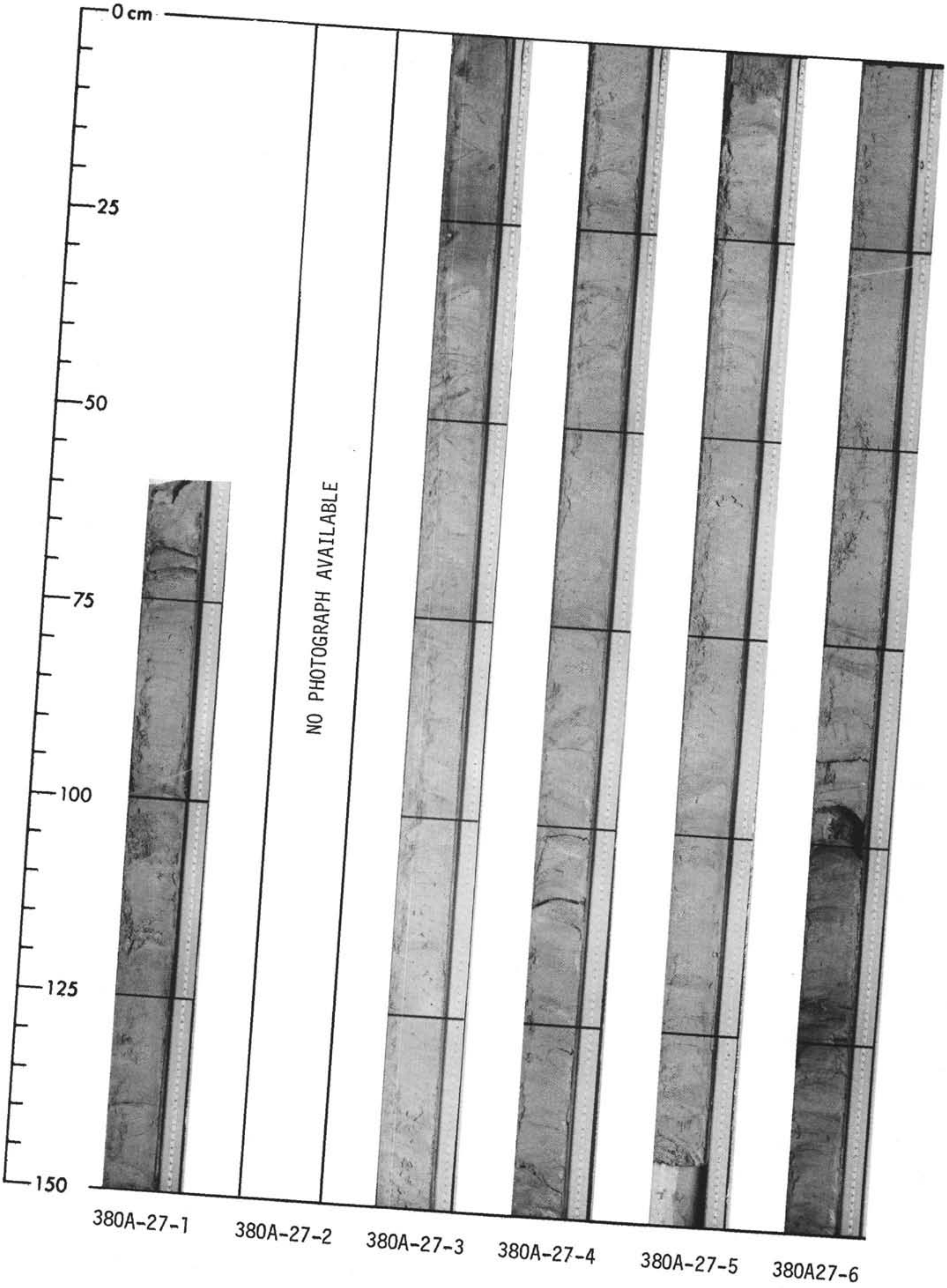
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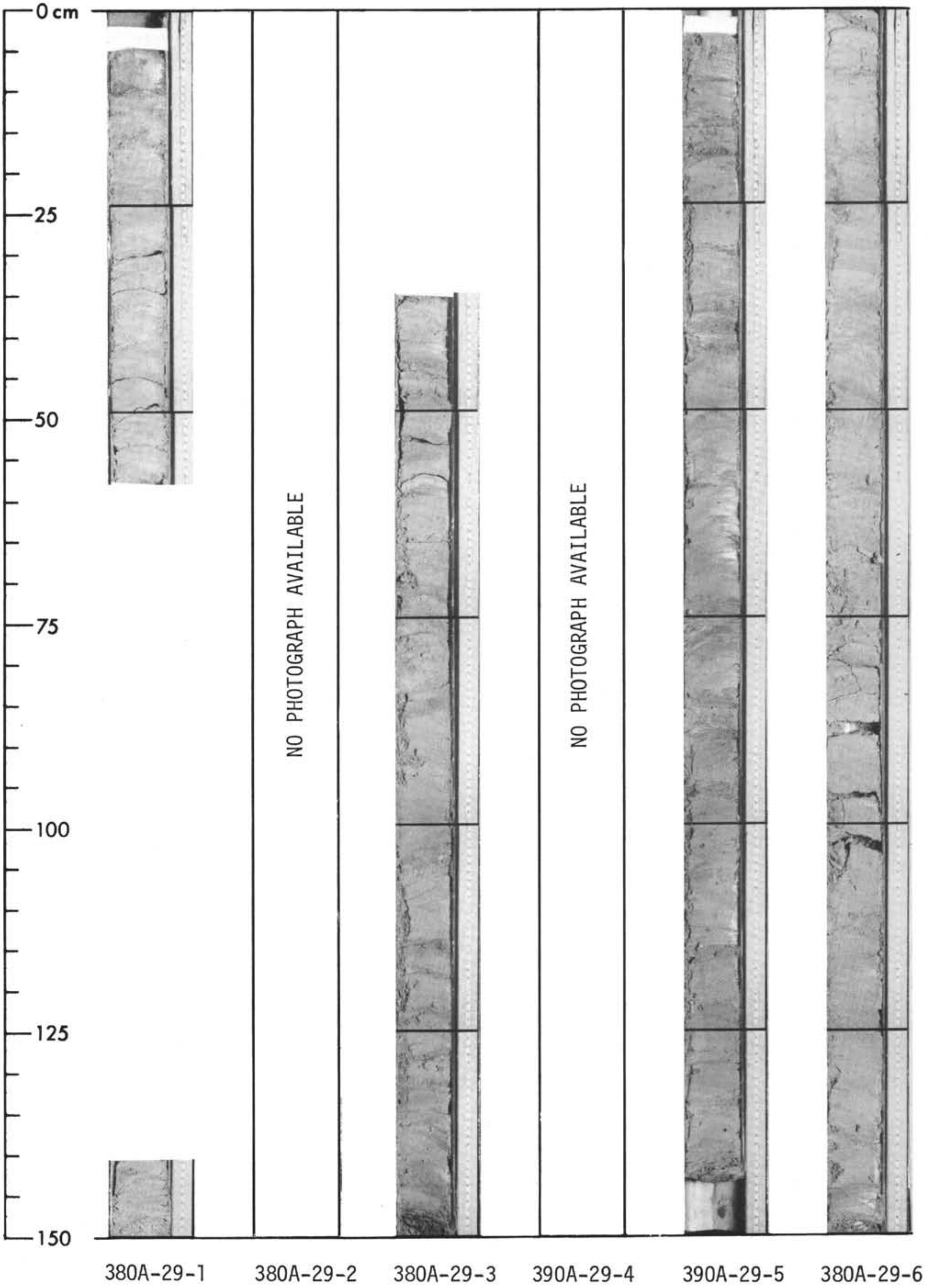
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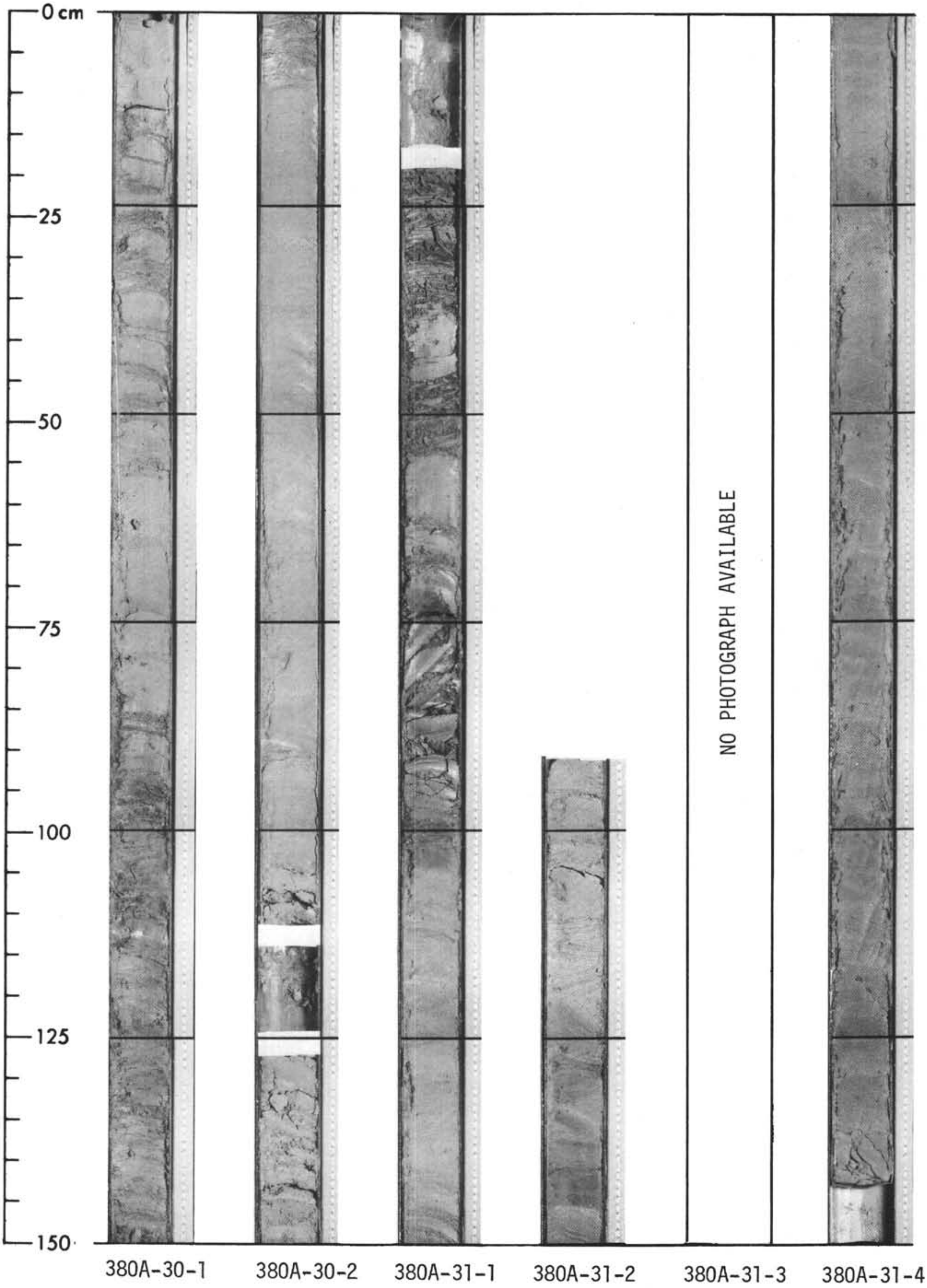
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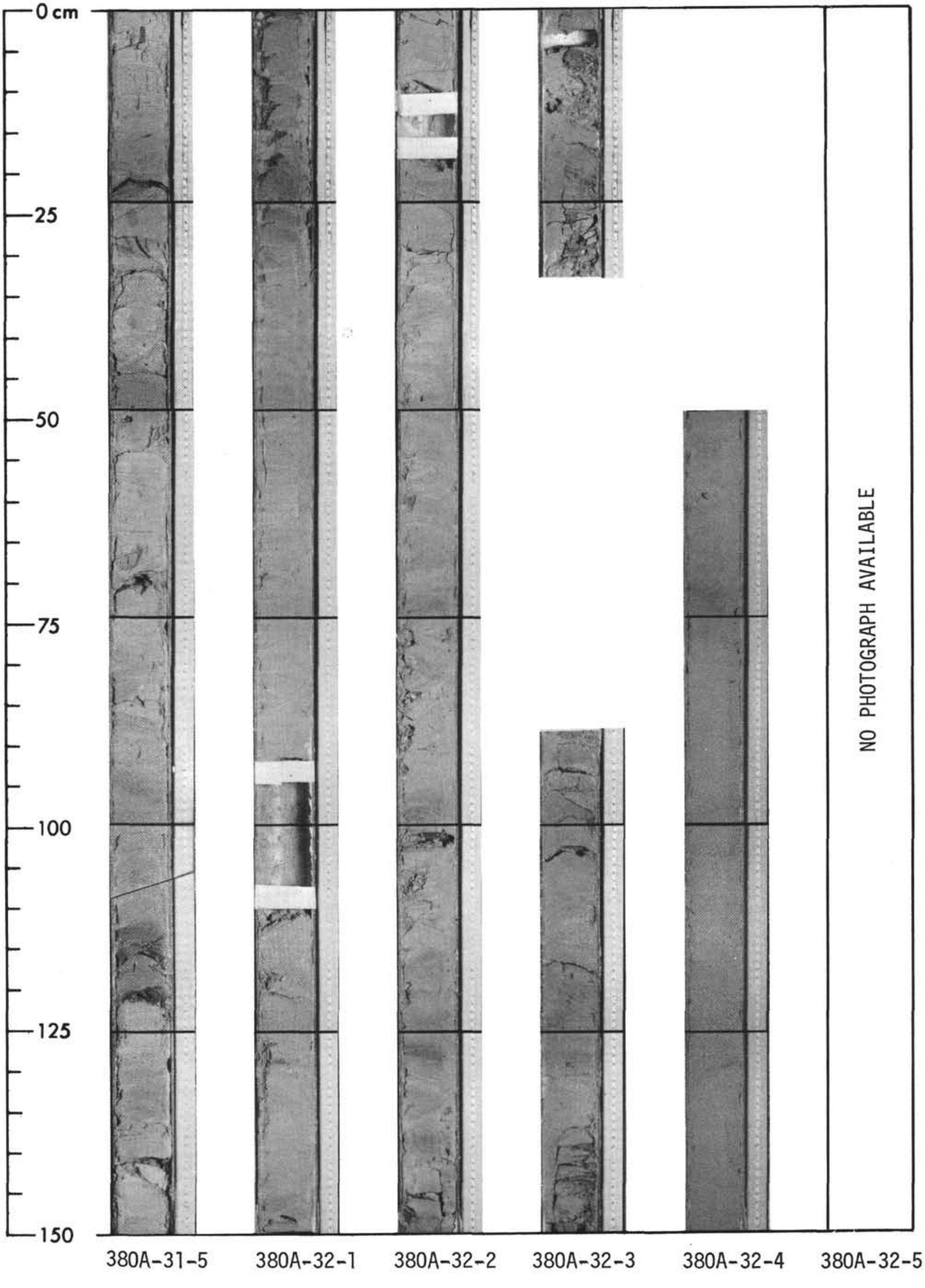
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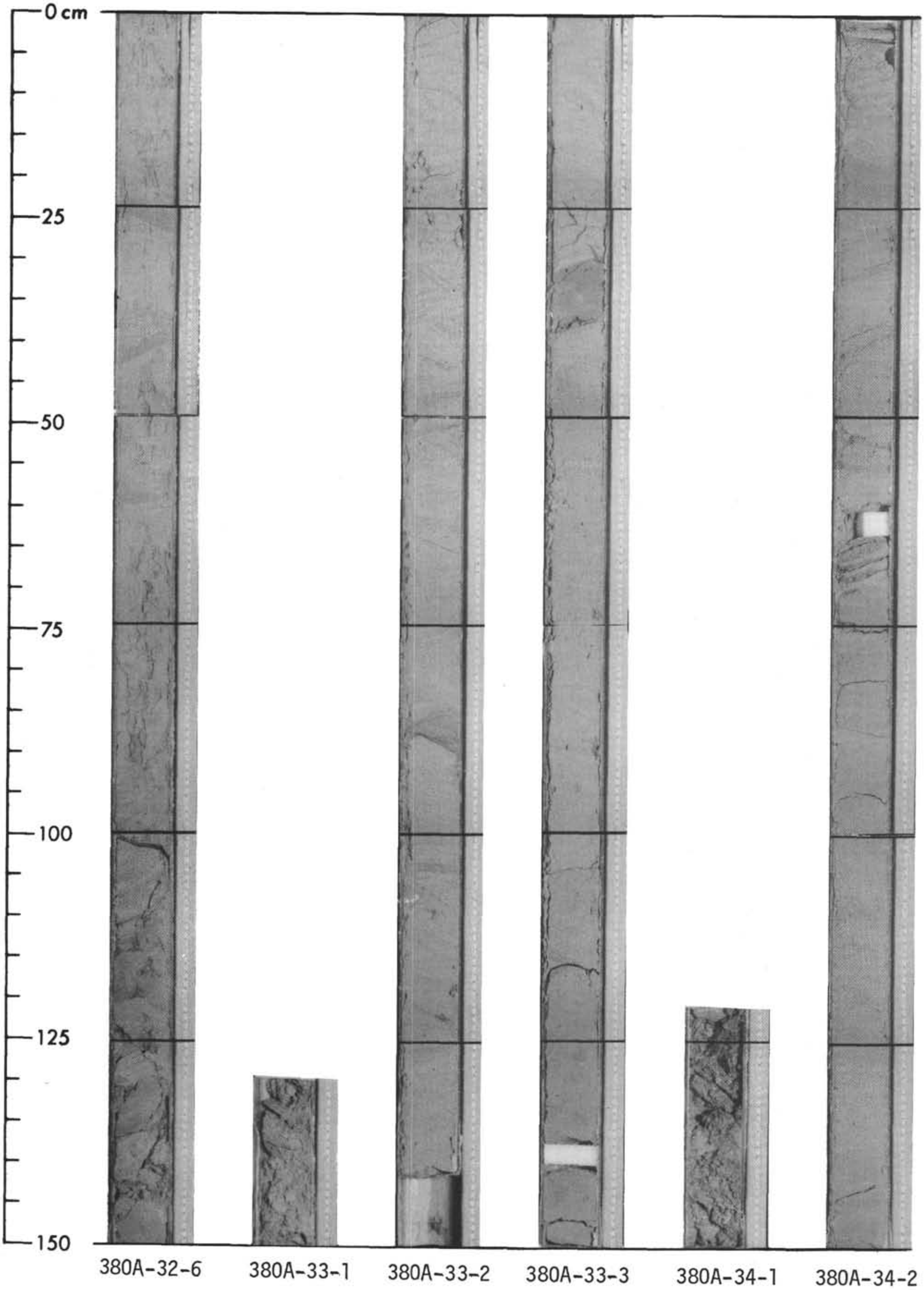
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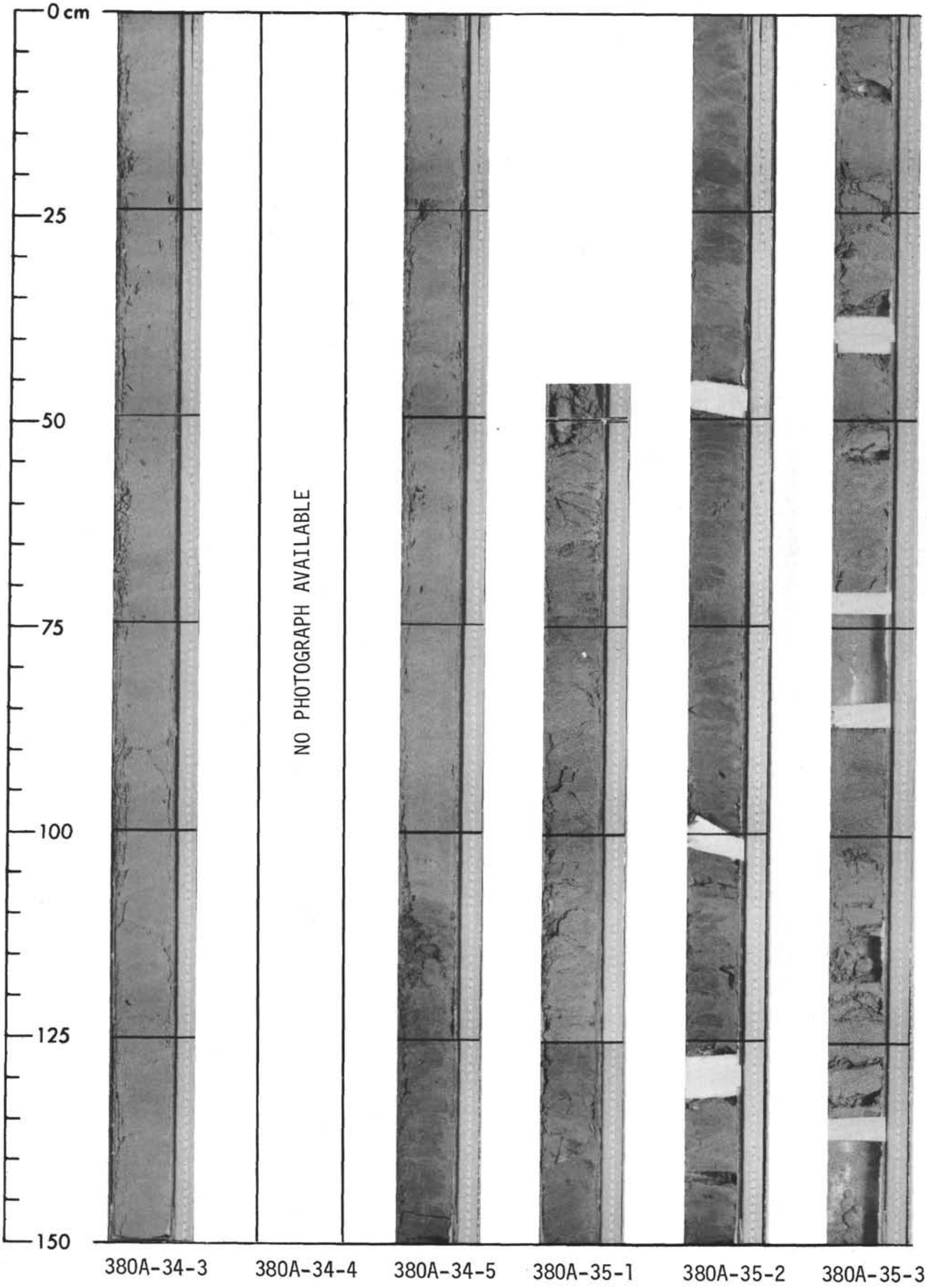
380A-34-2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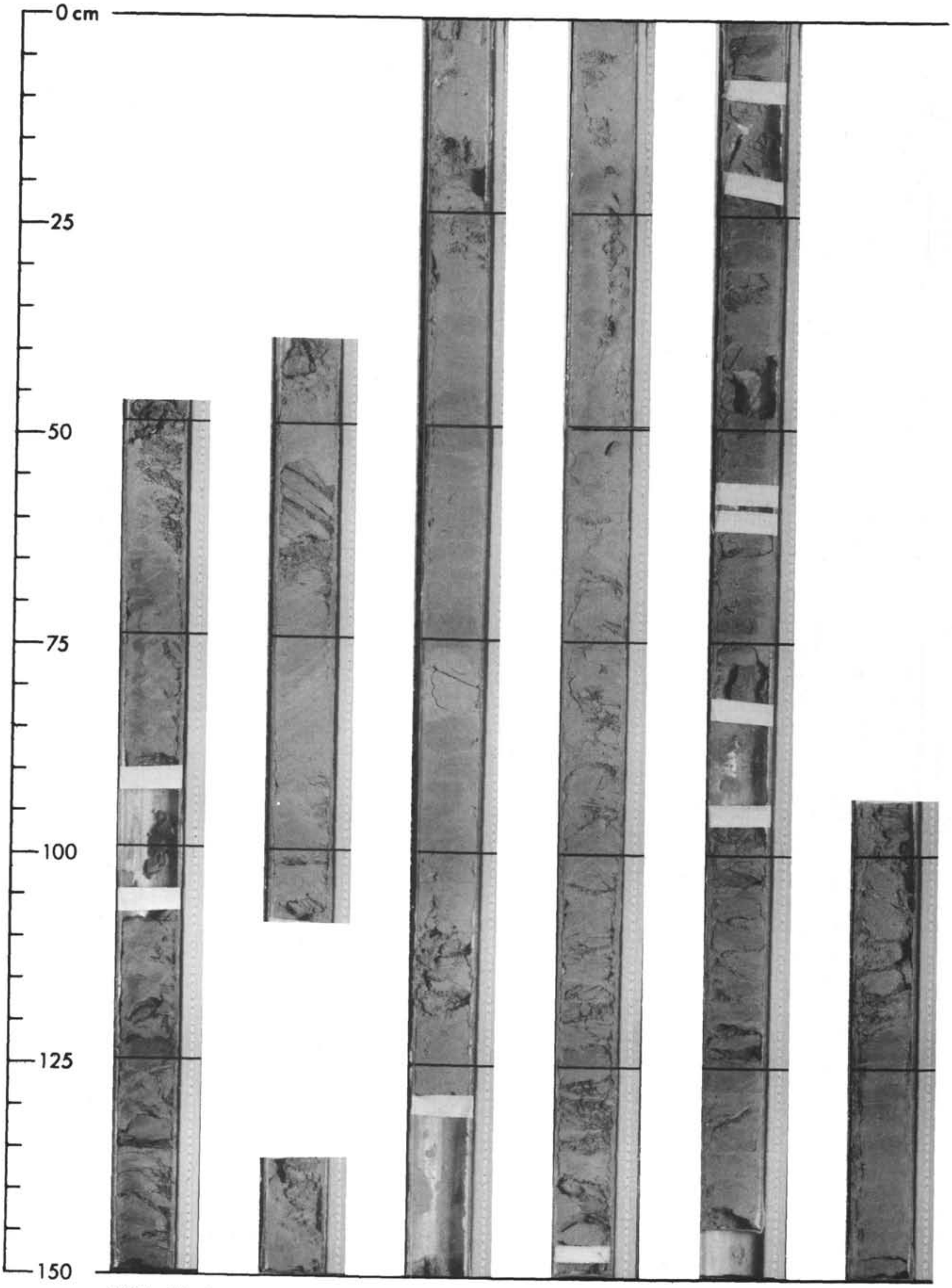
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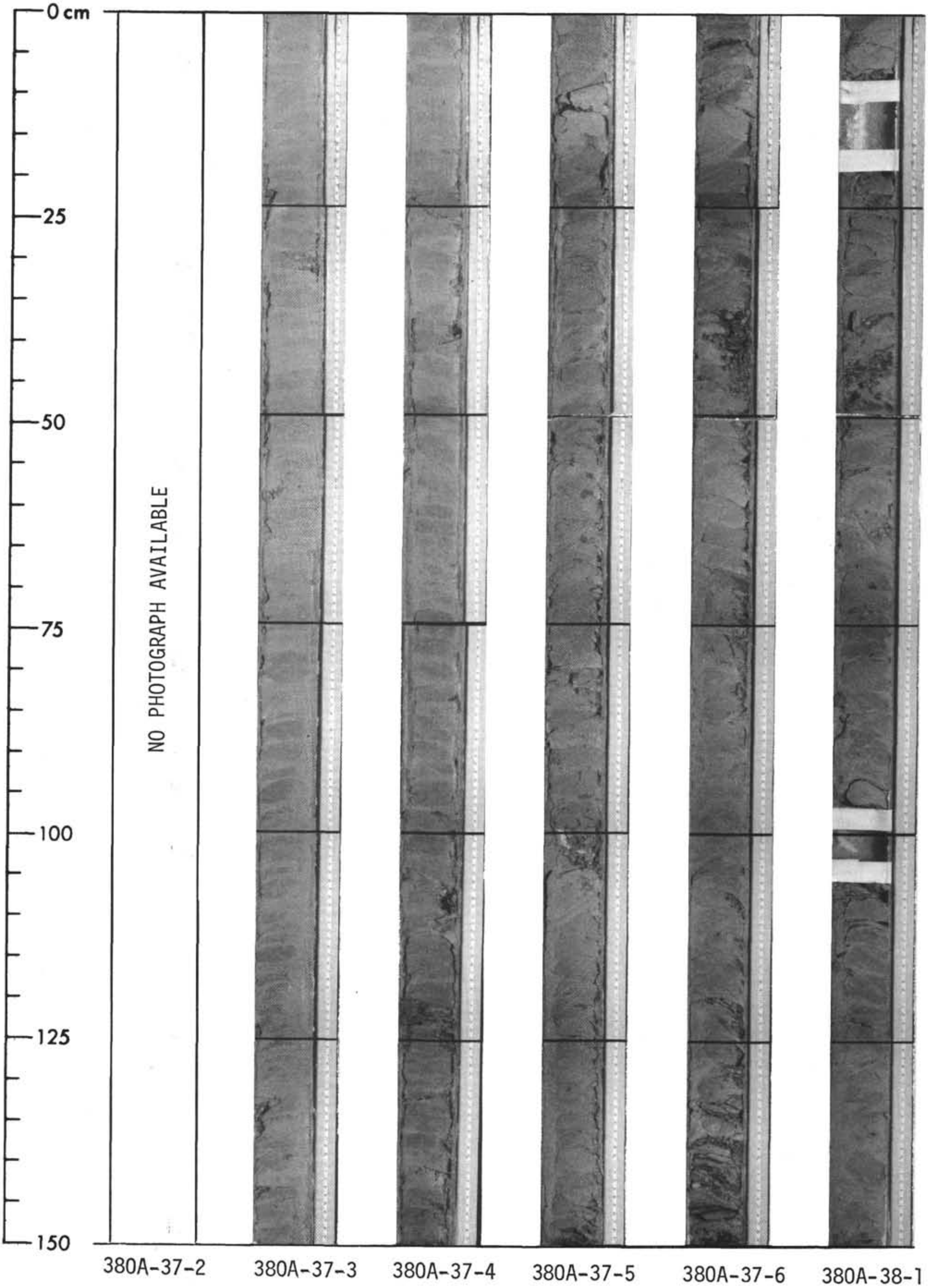
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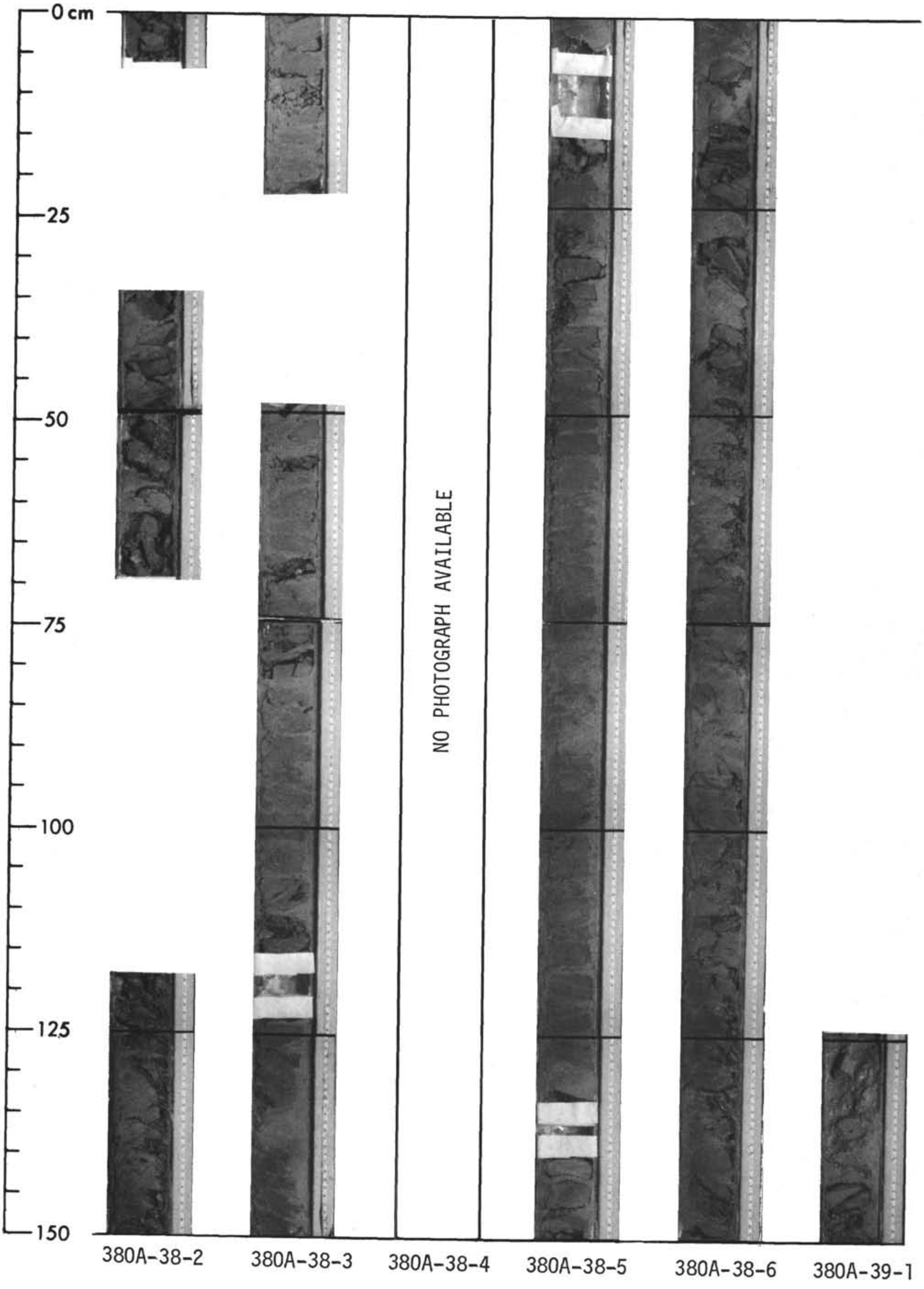
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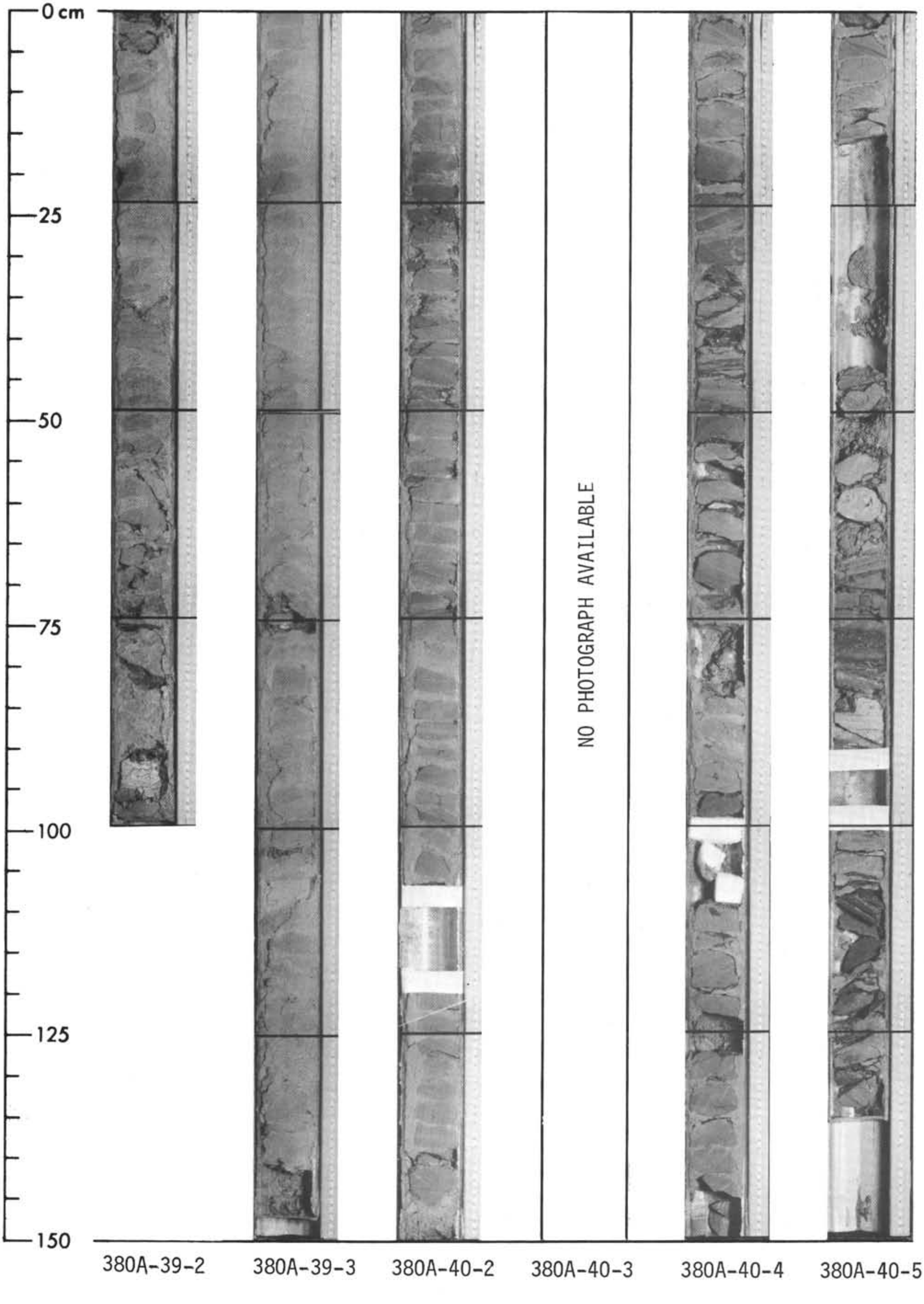
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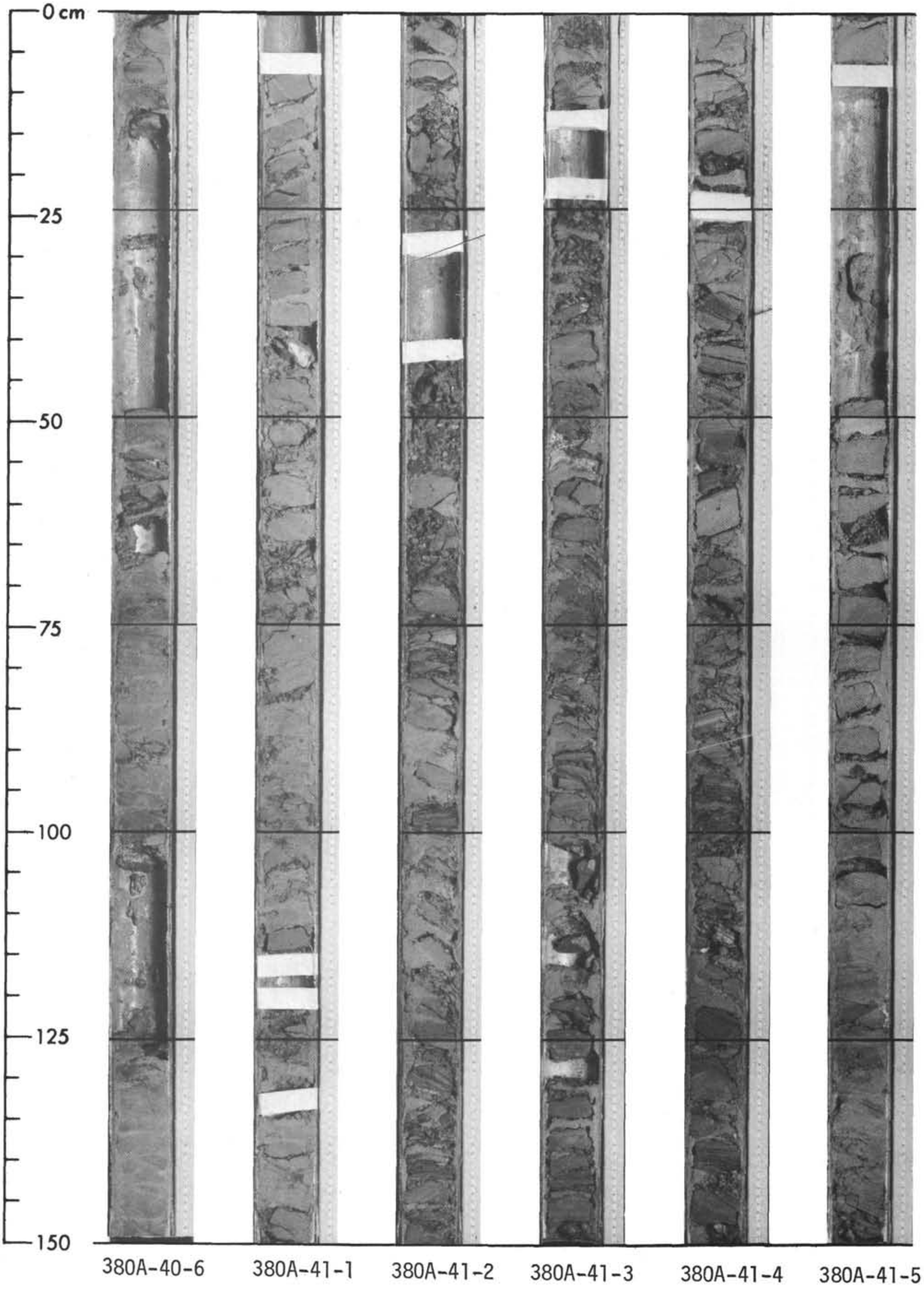
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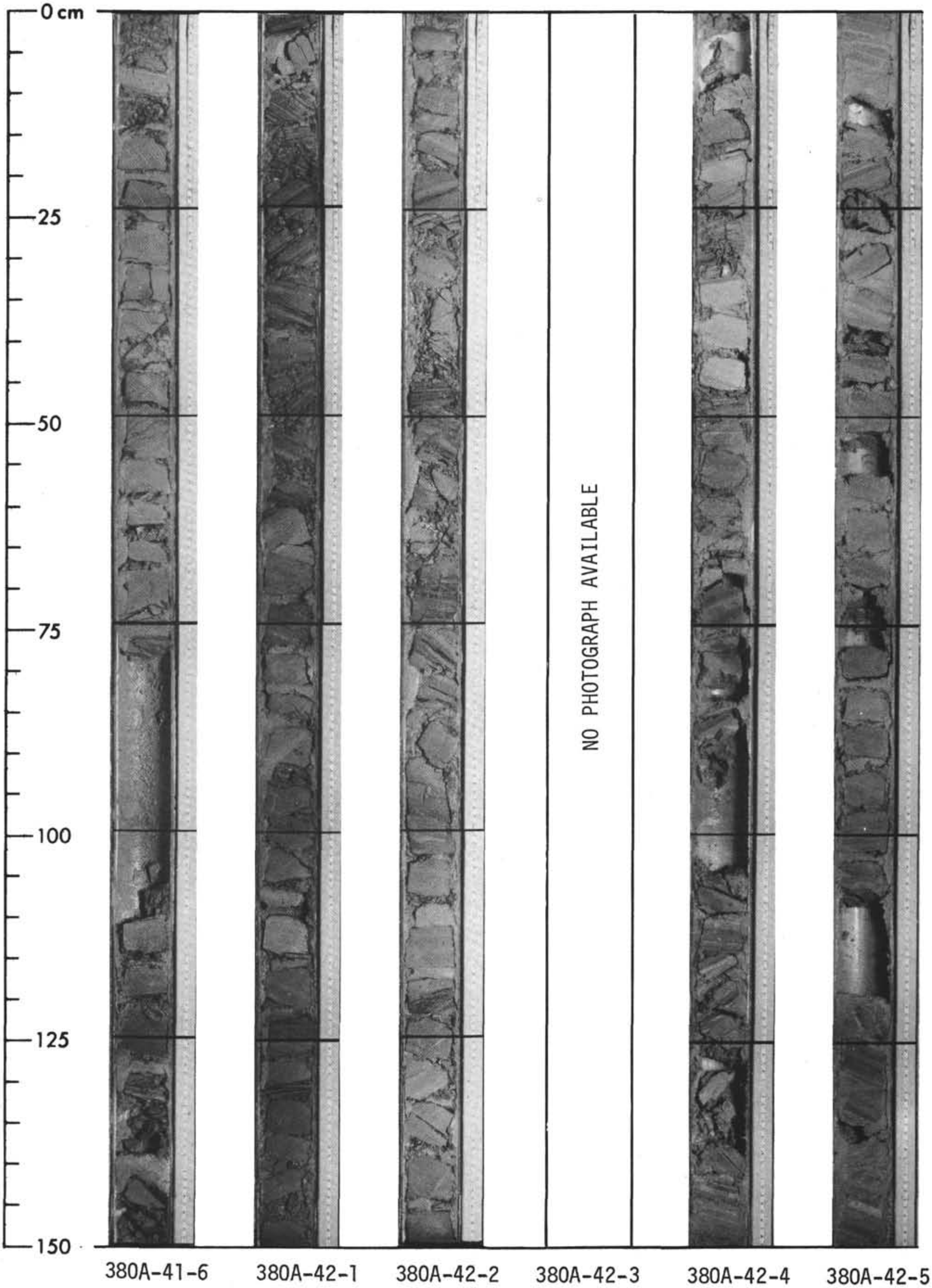
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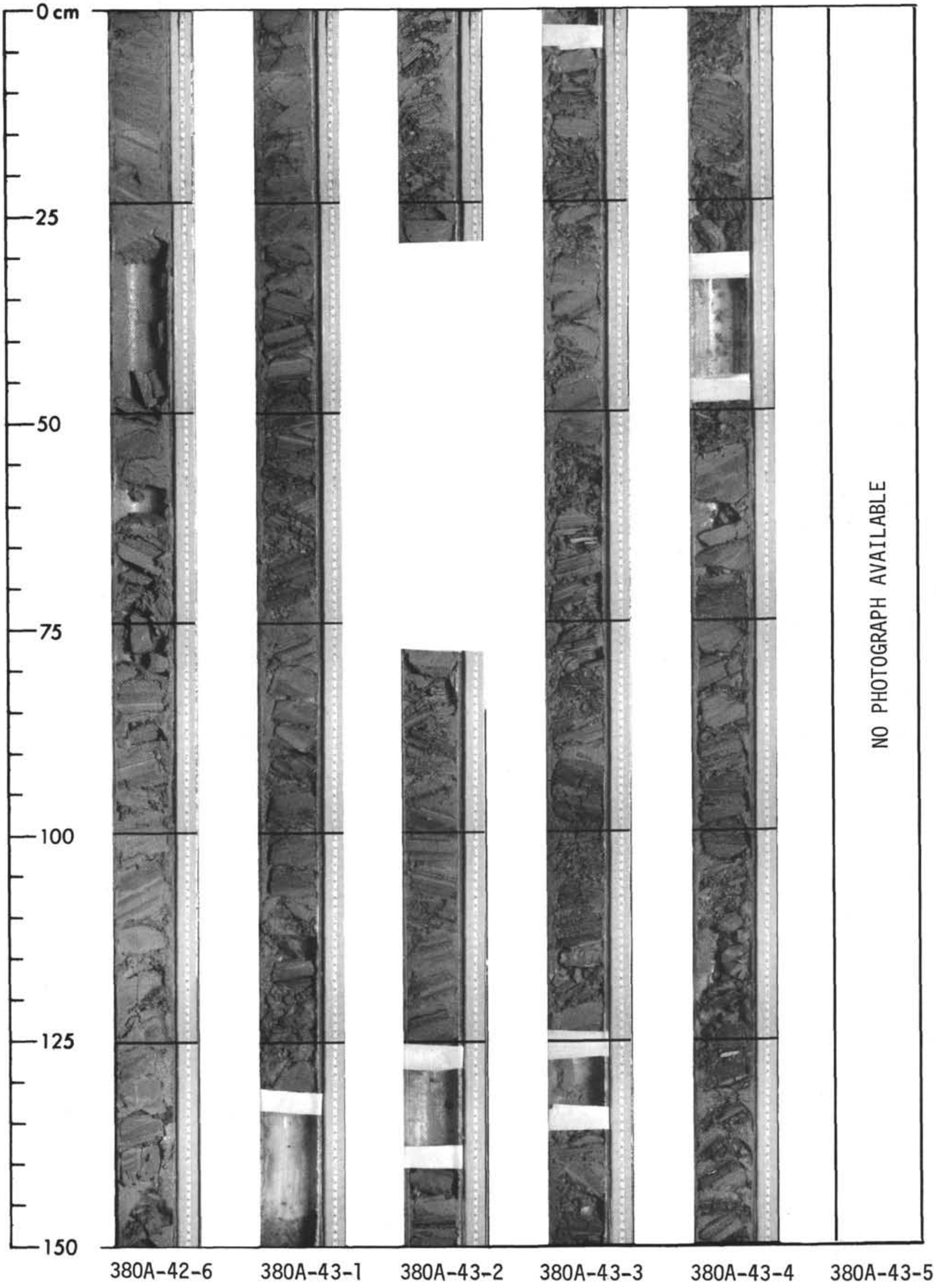
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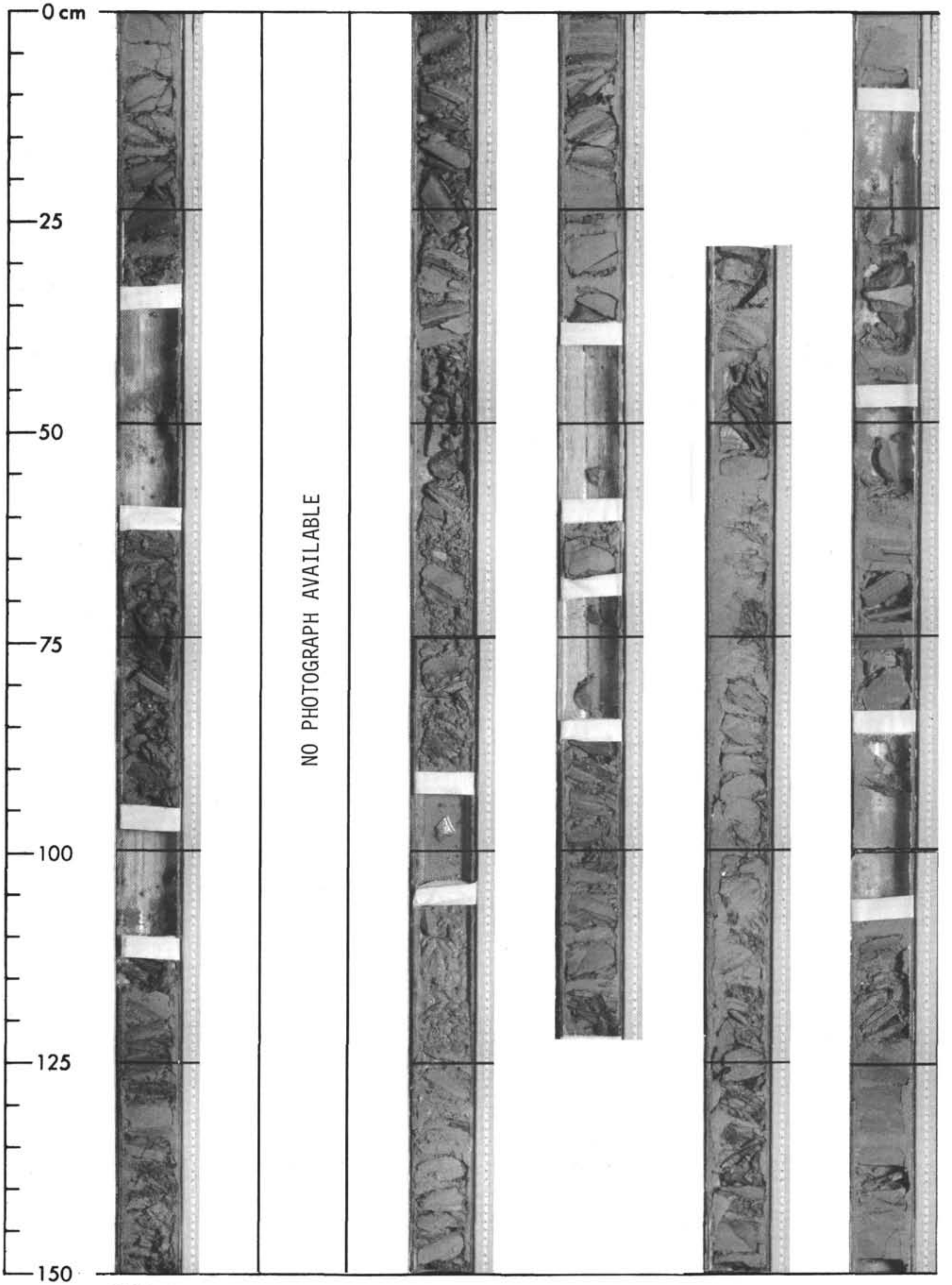
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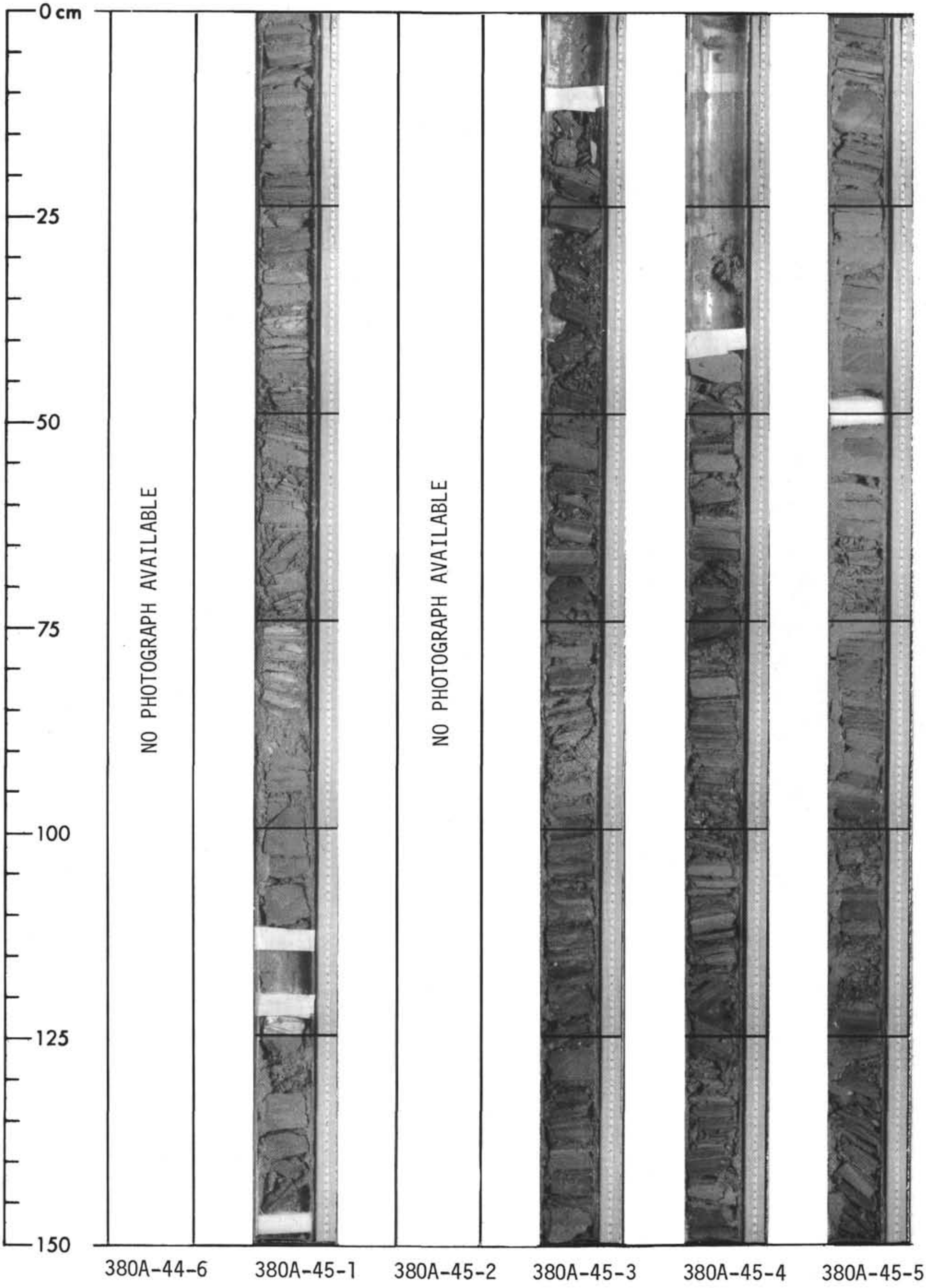
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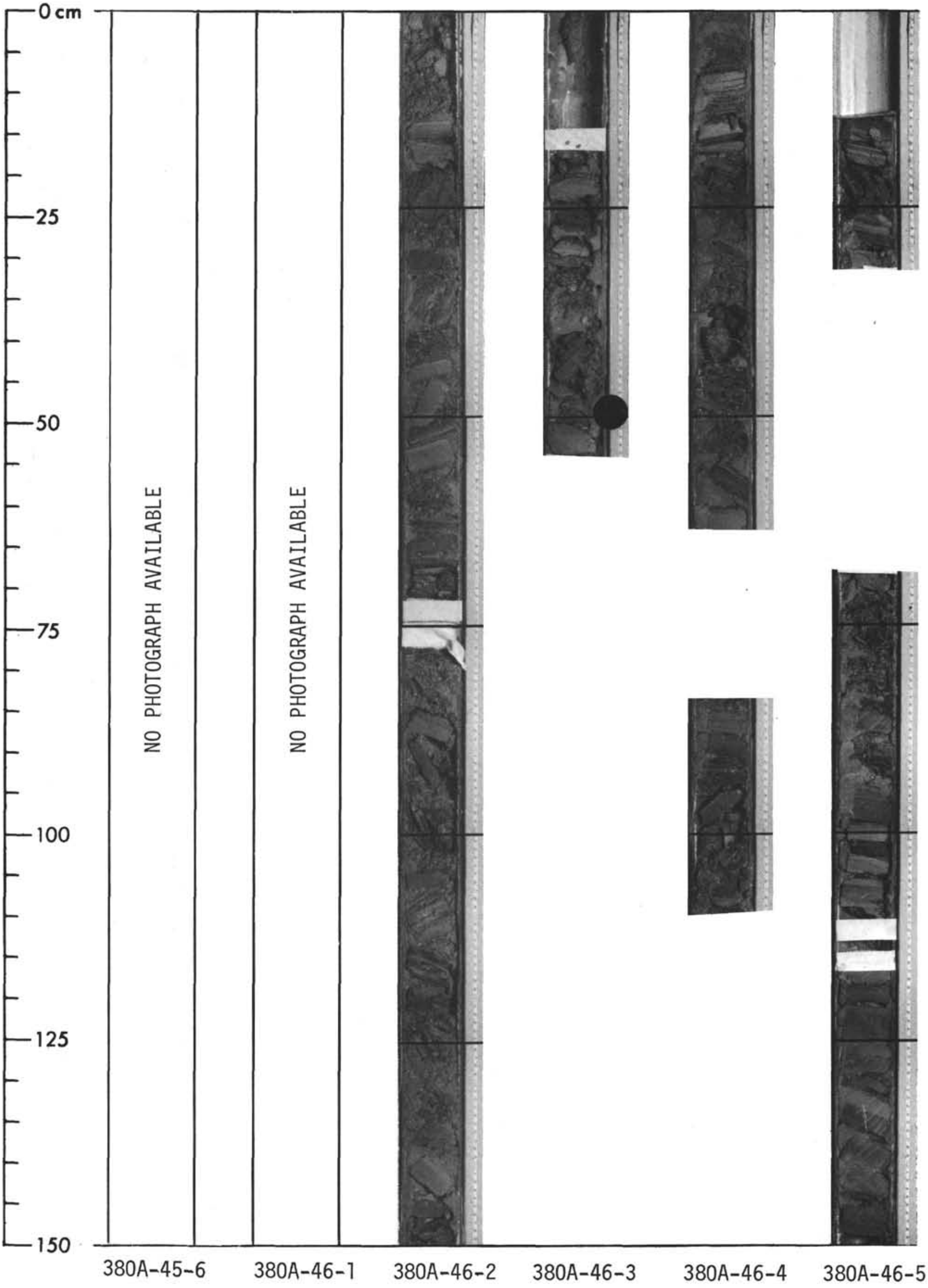
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380A-46-3
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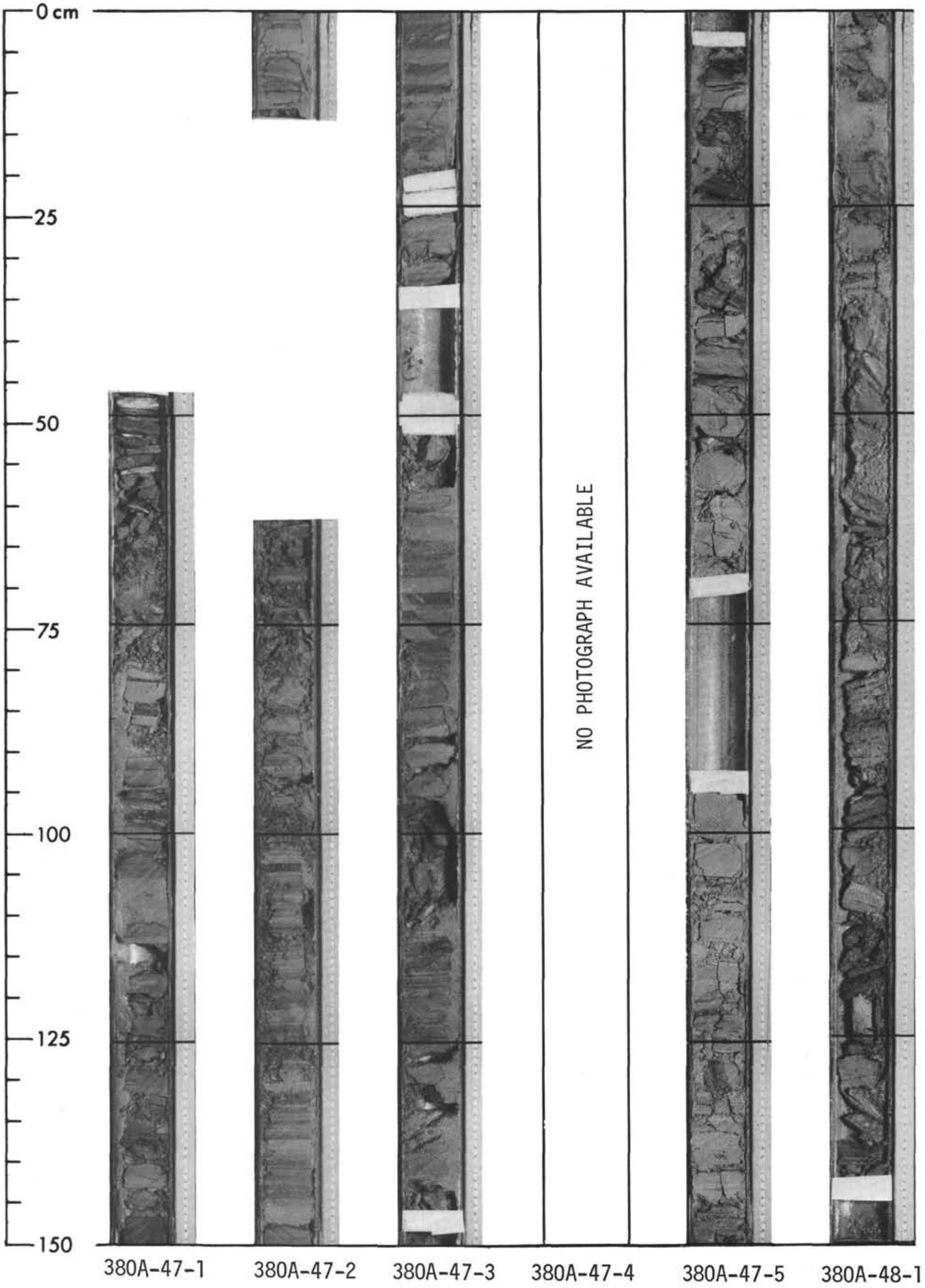
380A-46-5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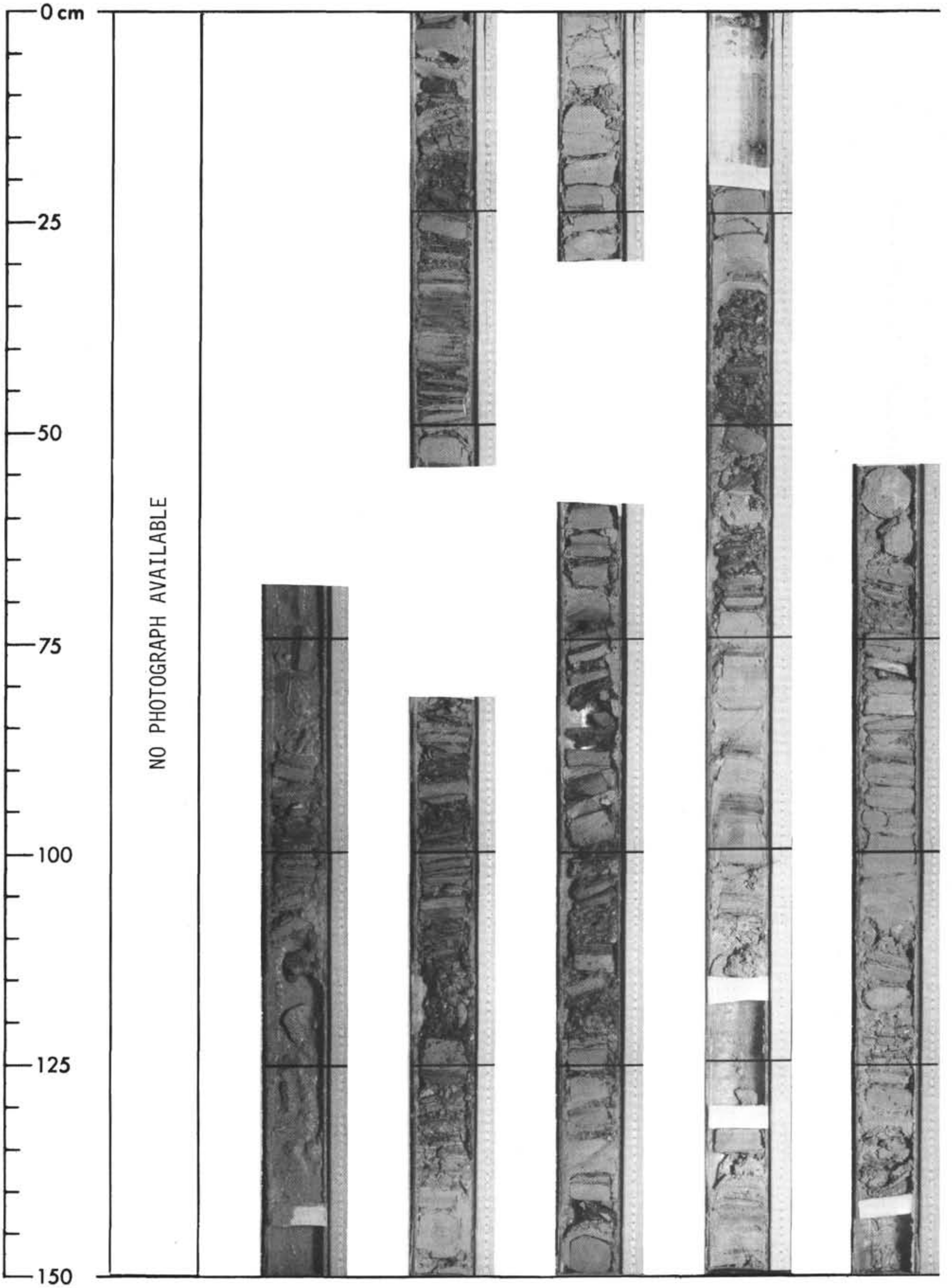
380A-47-5
380A-48-1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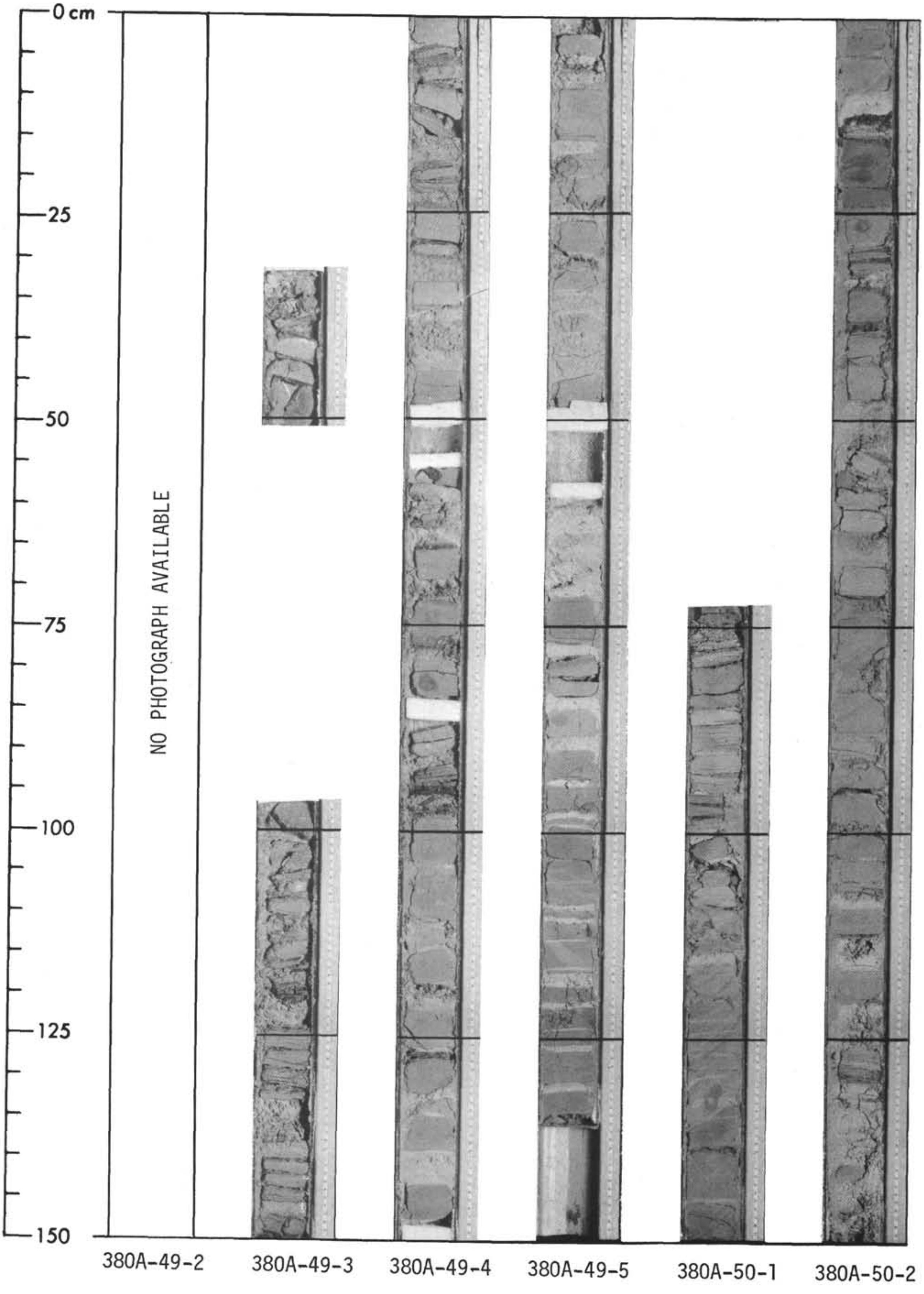
380A-49-1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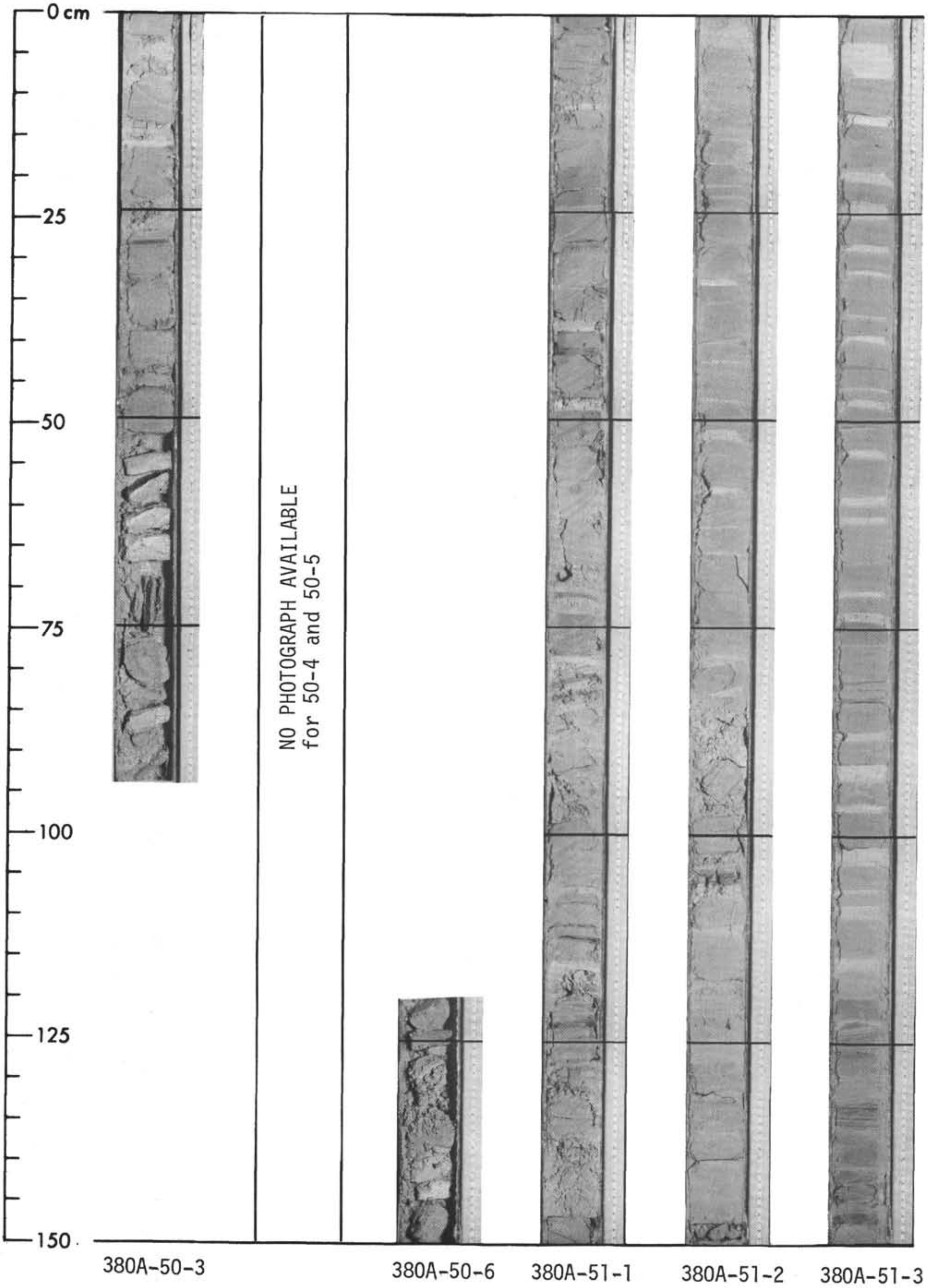
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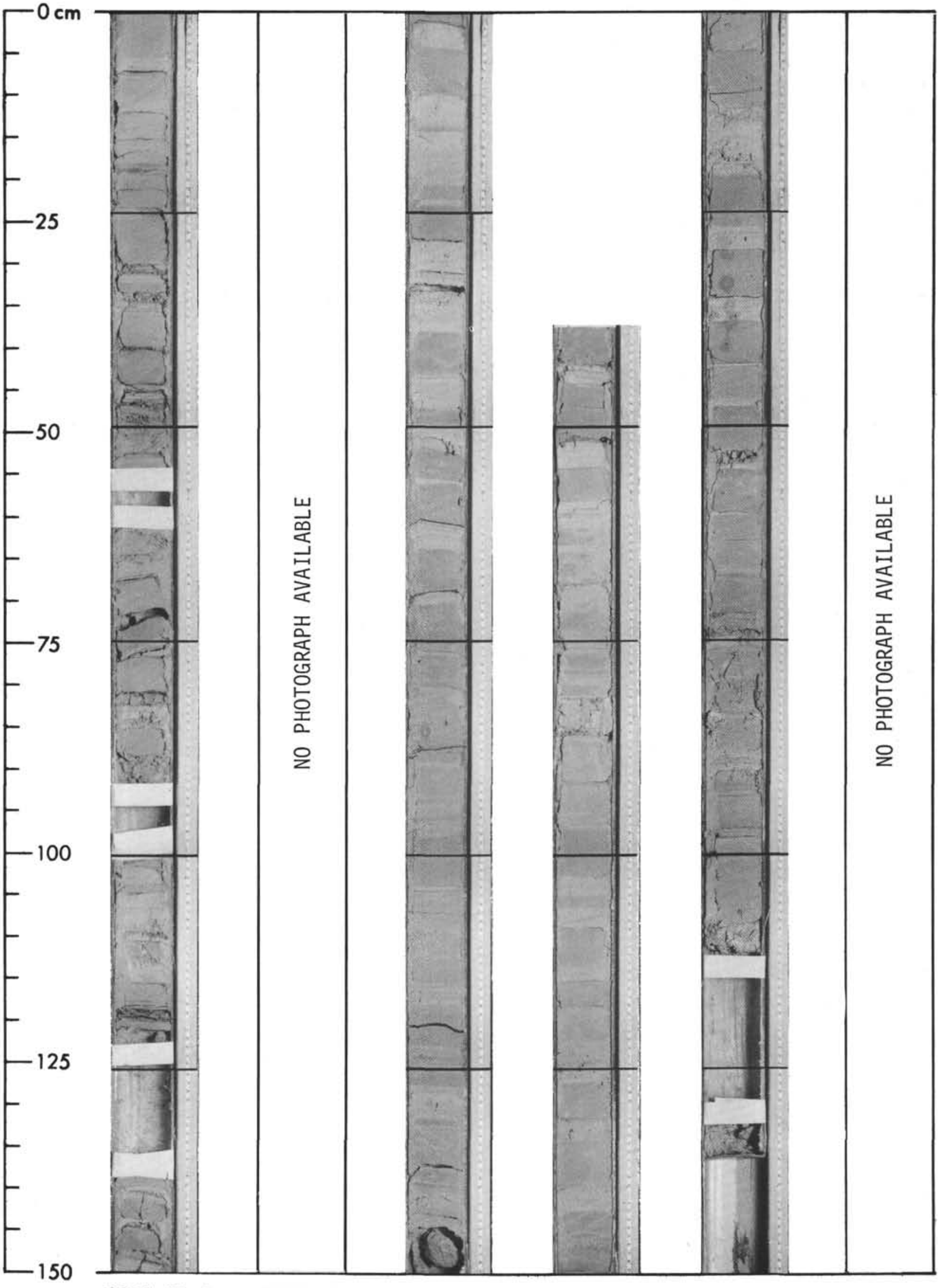
380A-50-6
380A-51-1
380A-51-2
380A-51-3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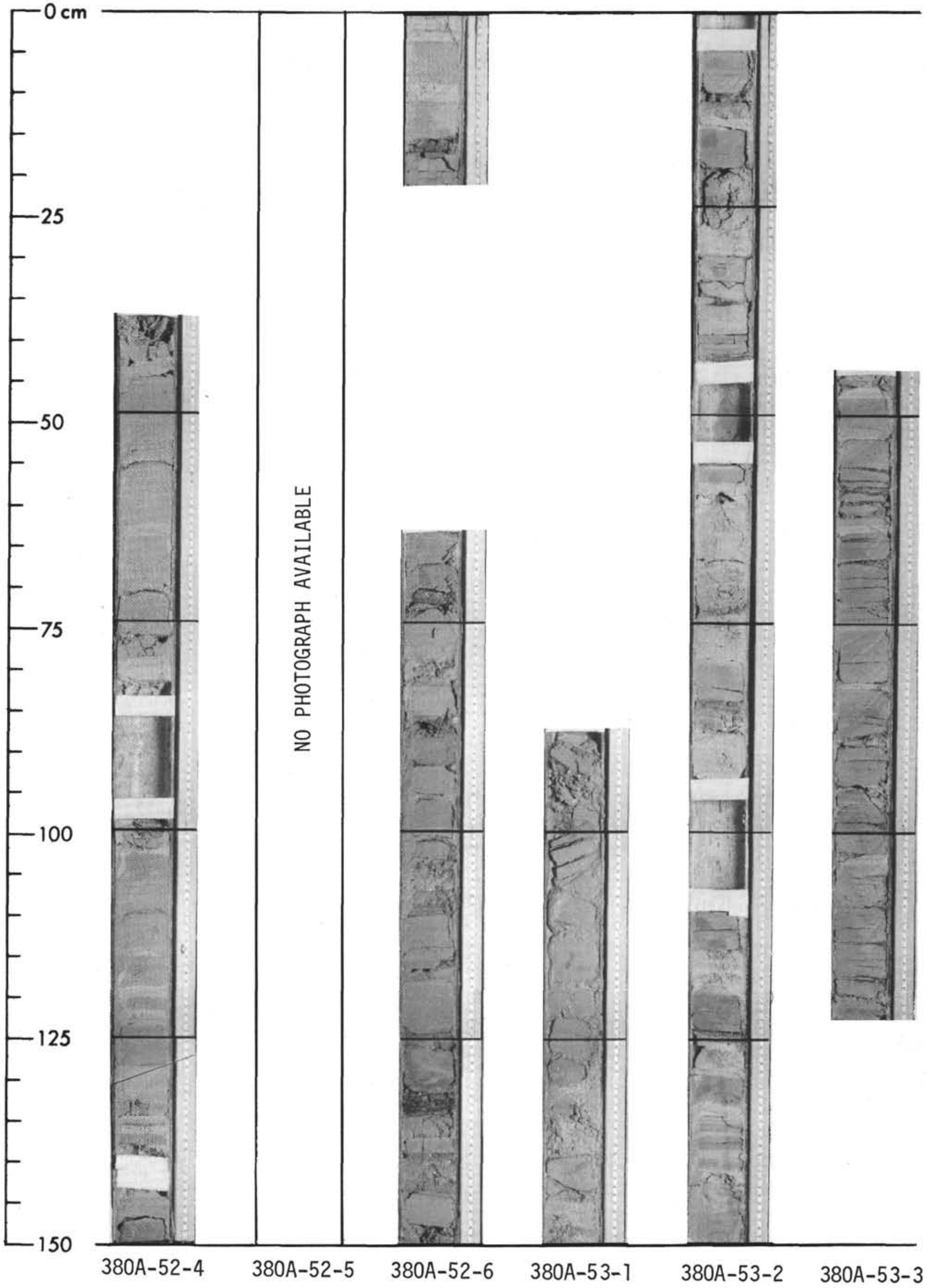
380A-51-6
380A-52-1
380A-52-2
380A-52-3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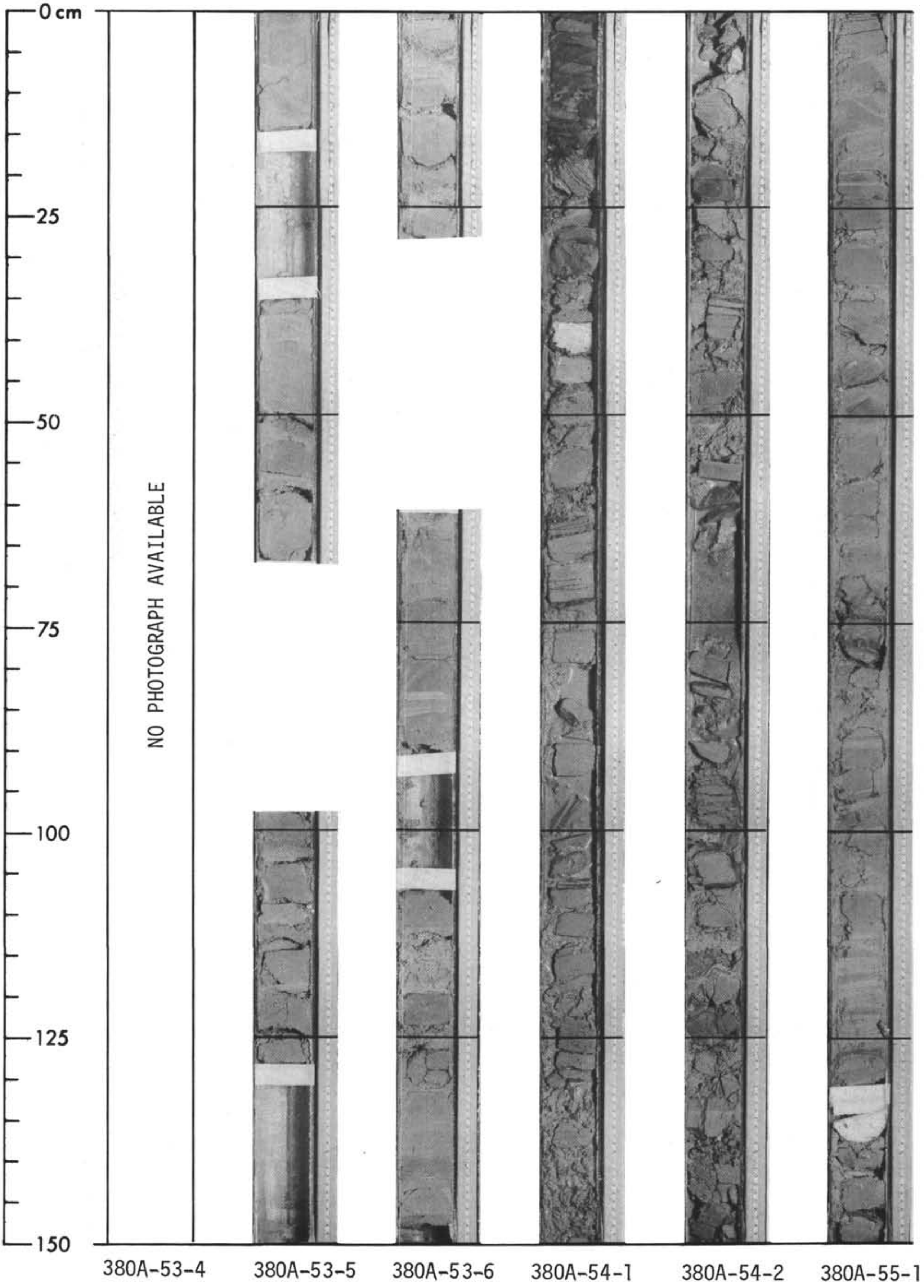
380A-53-2
380A-53-3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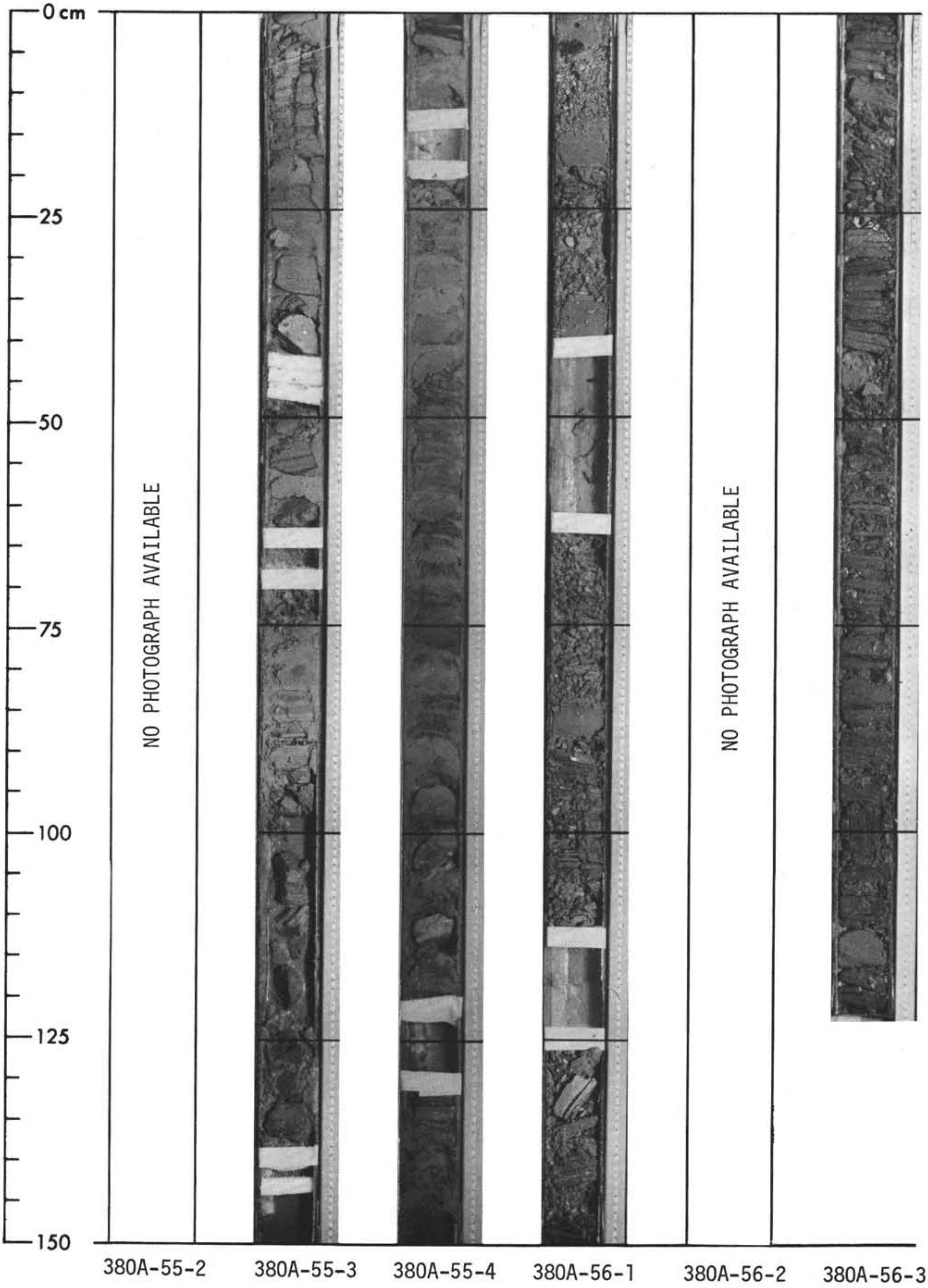
380A-55-1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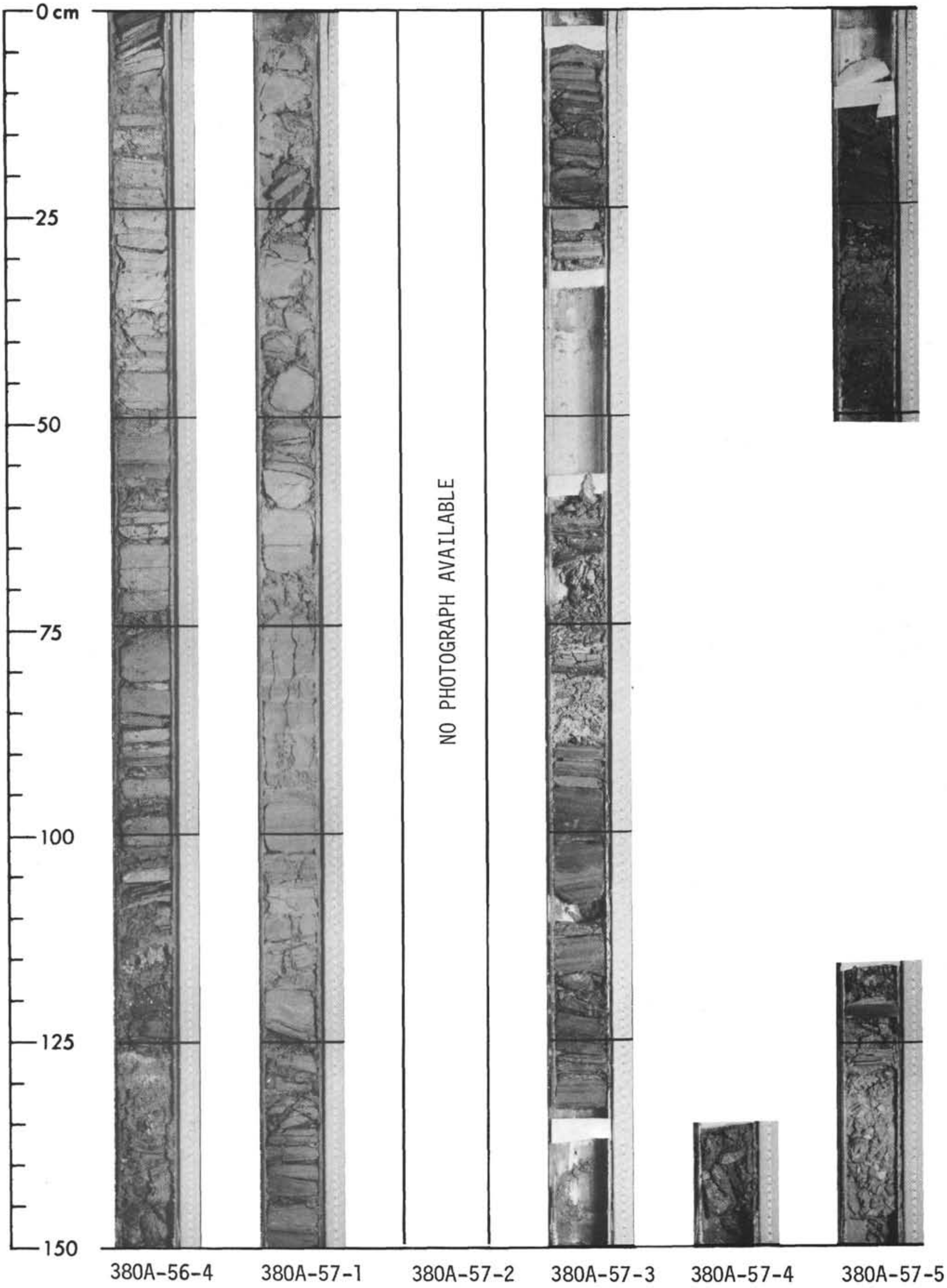
380A-56-1
380A-56-2
380A-56-3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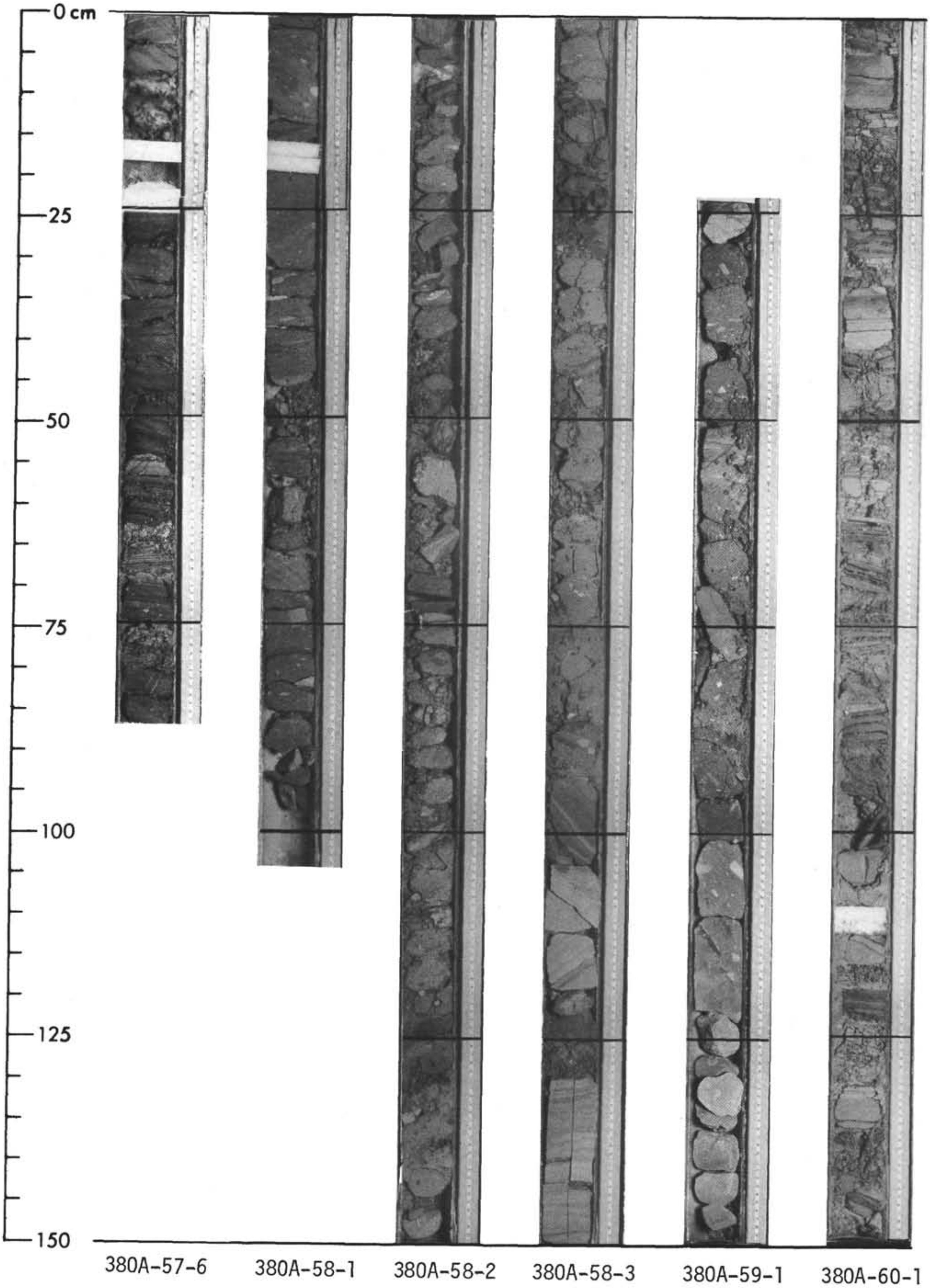
380A-57-5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380A-57-6
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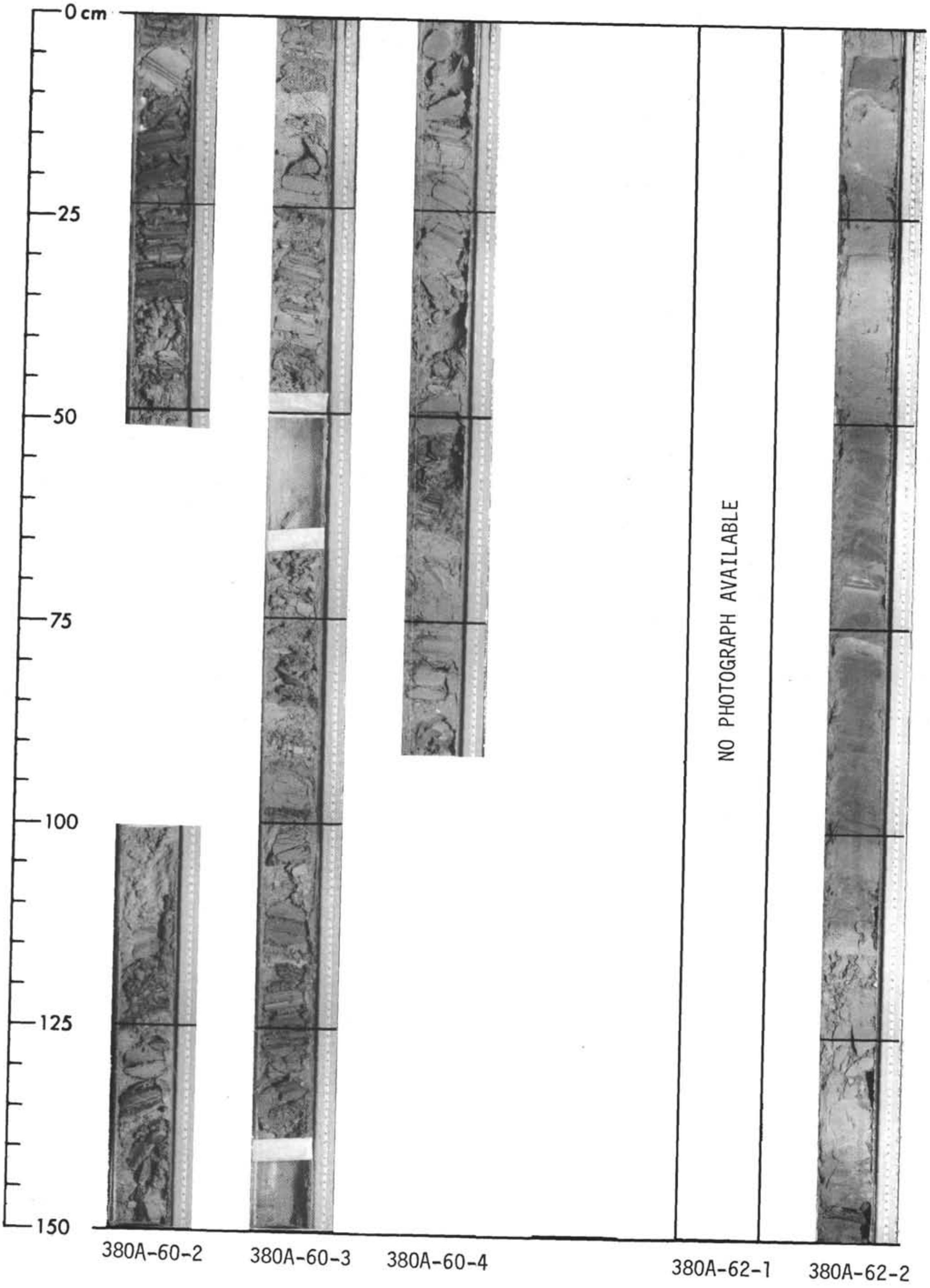
380A-60-1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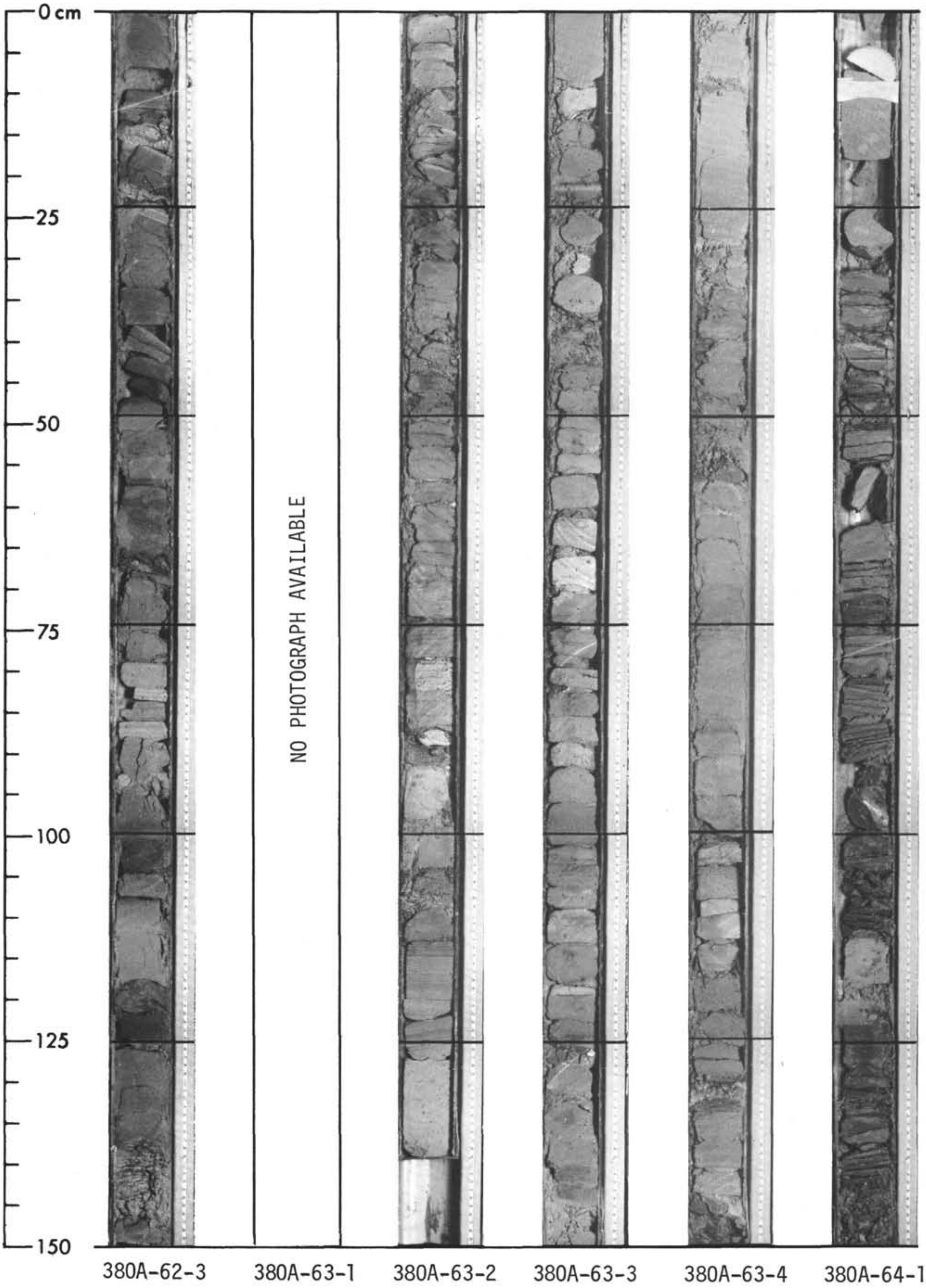
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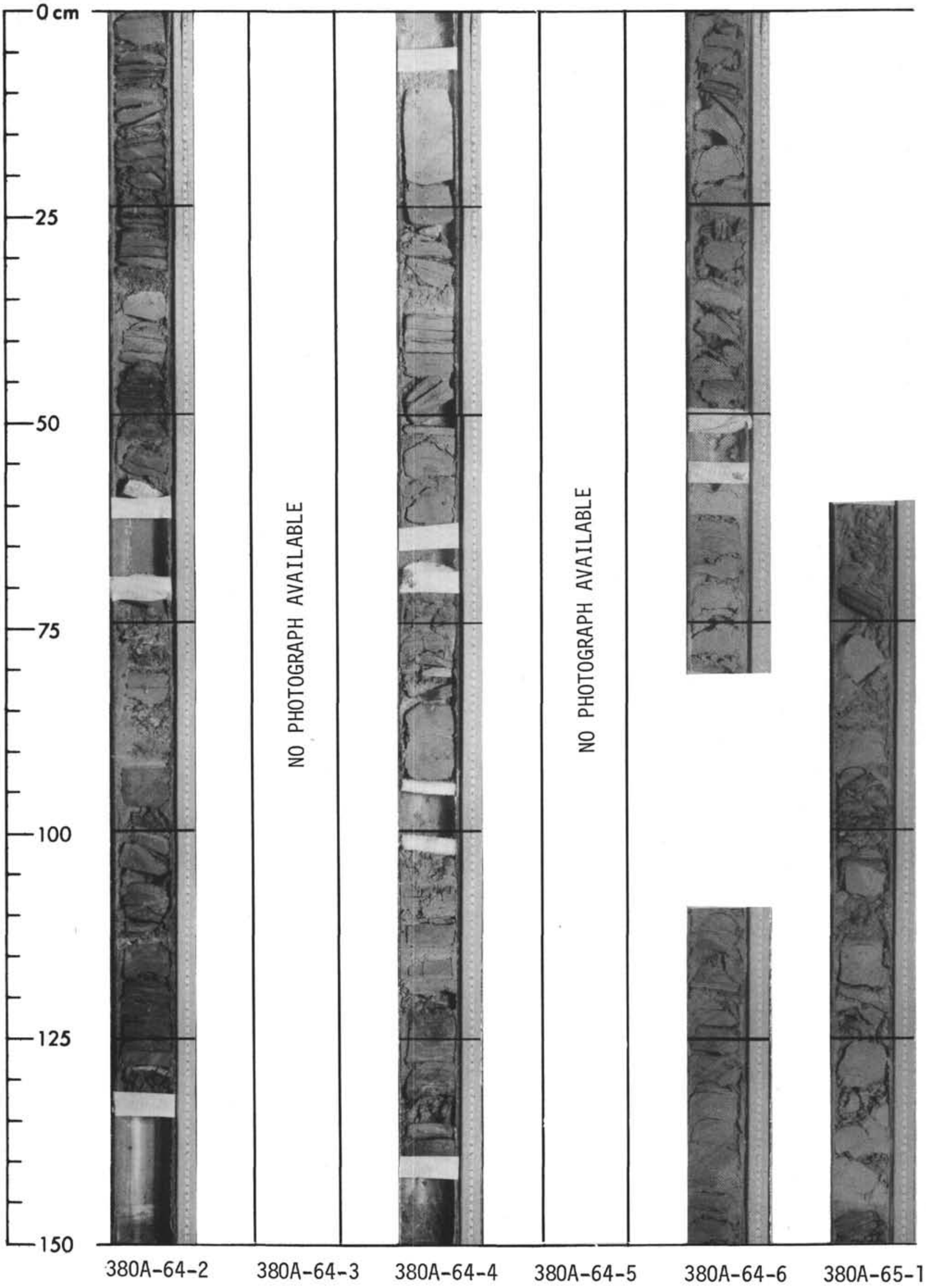
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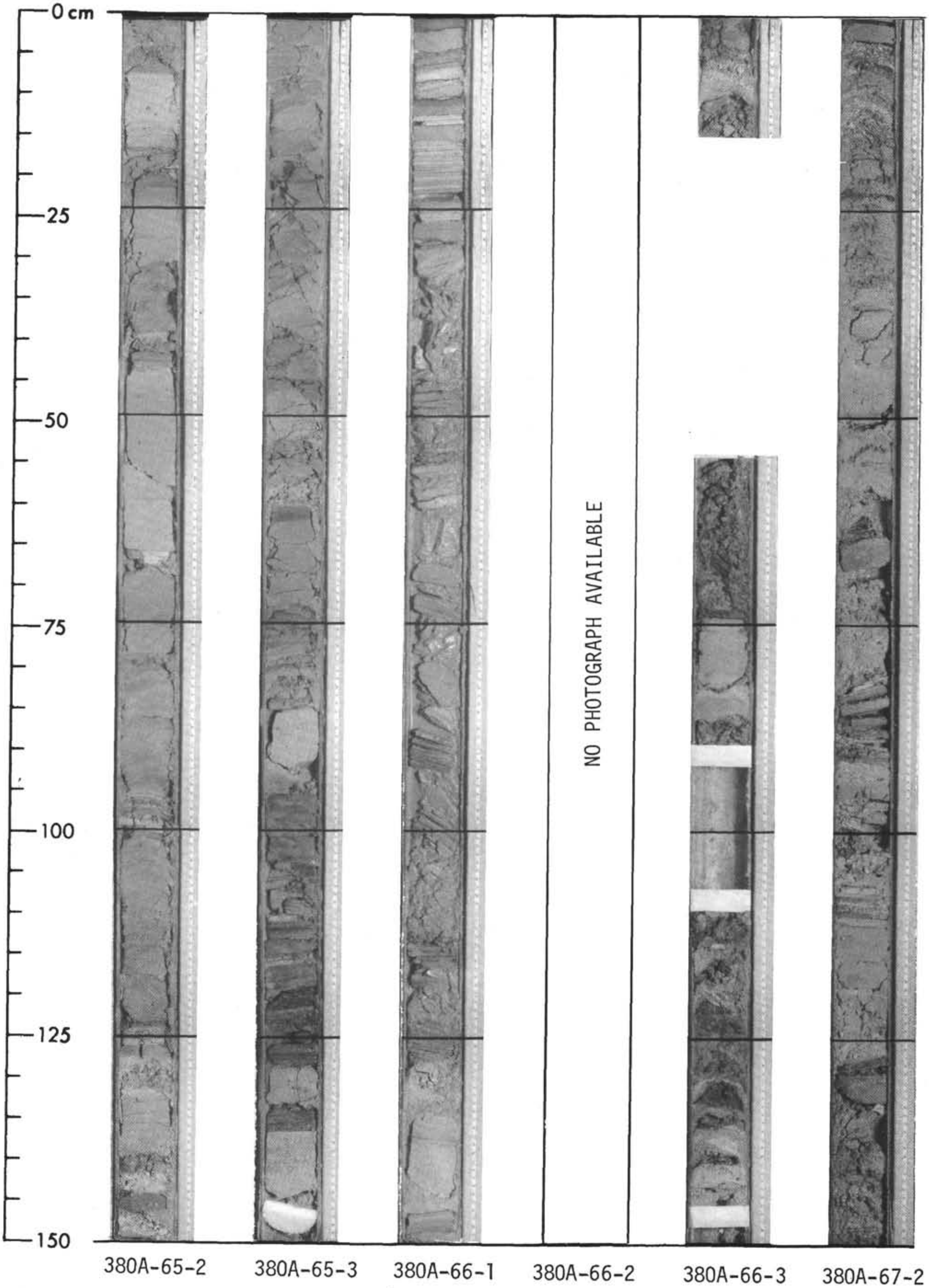
380A-64-6
380A-65-1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380A-66-3
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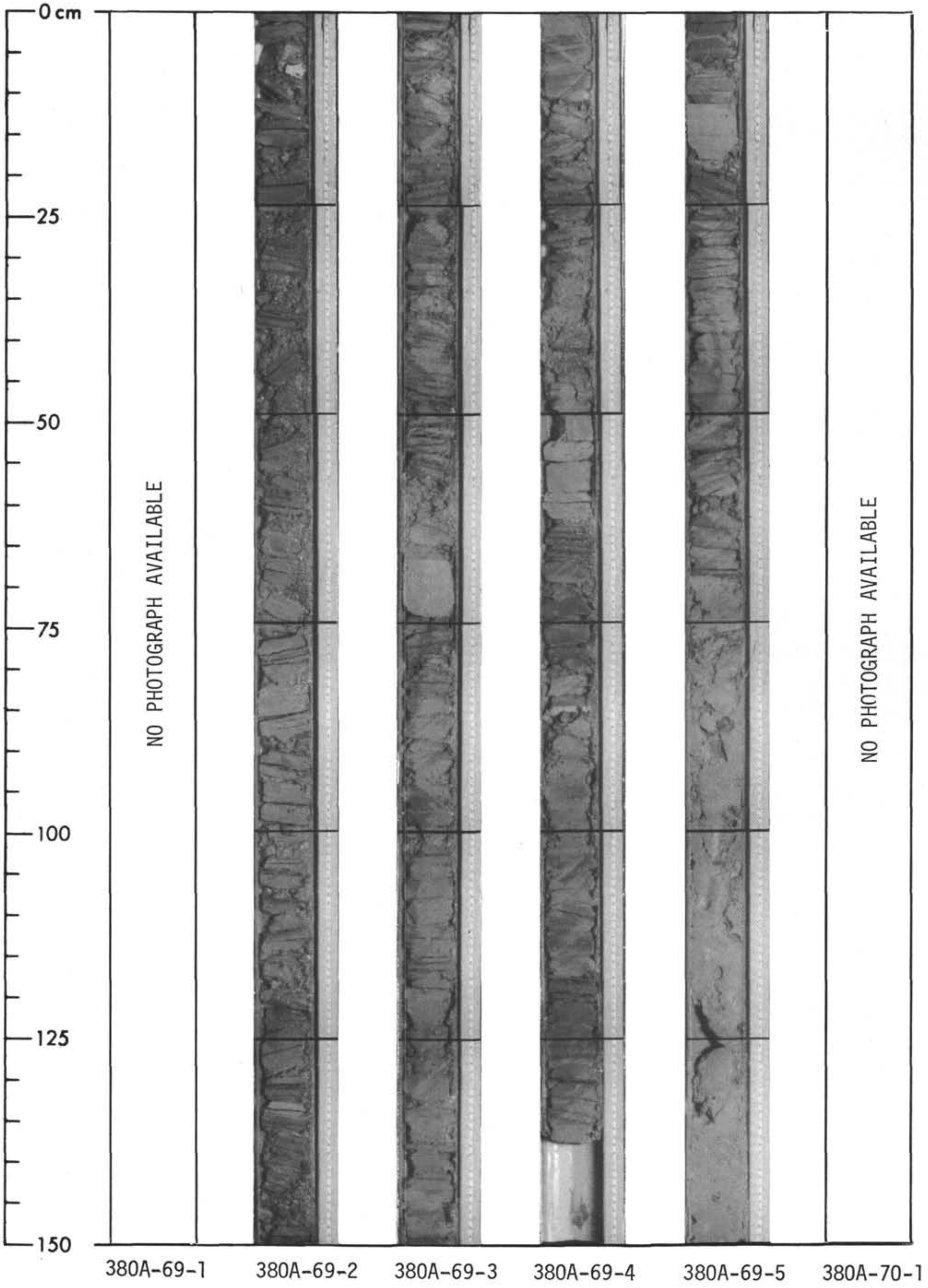
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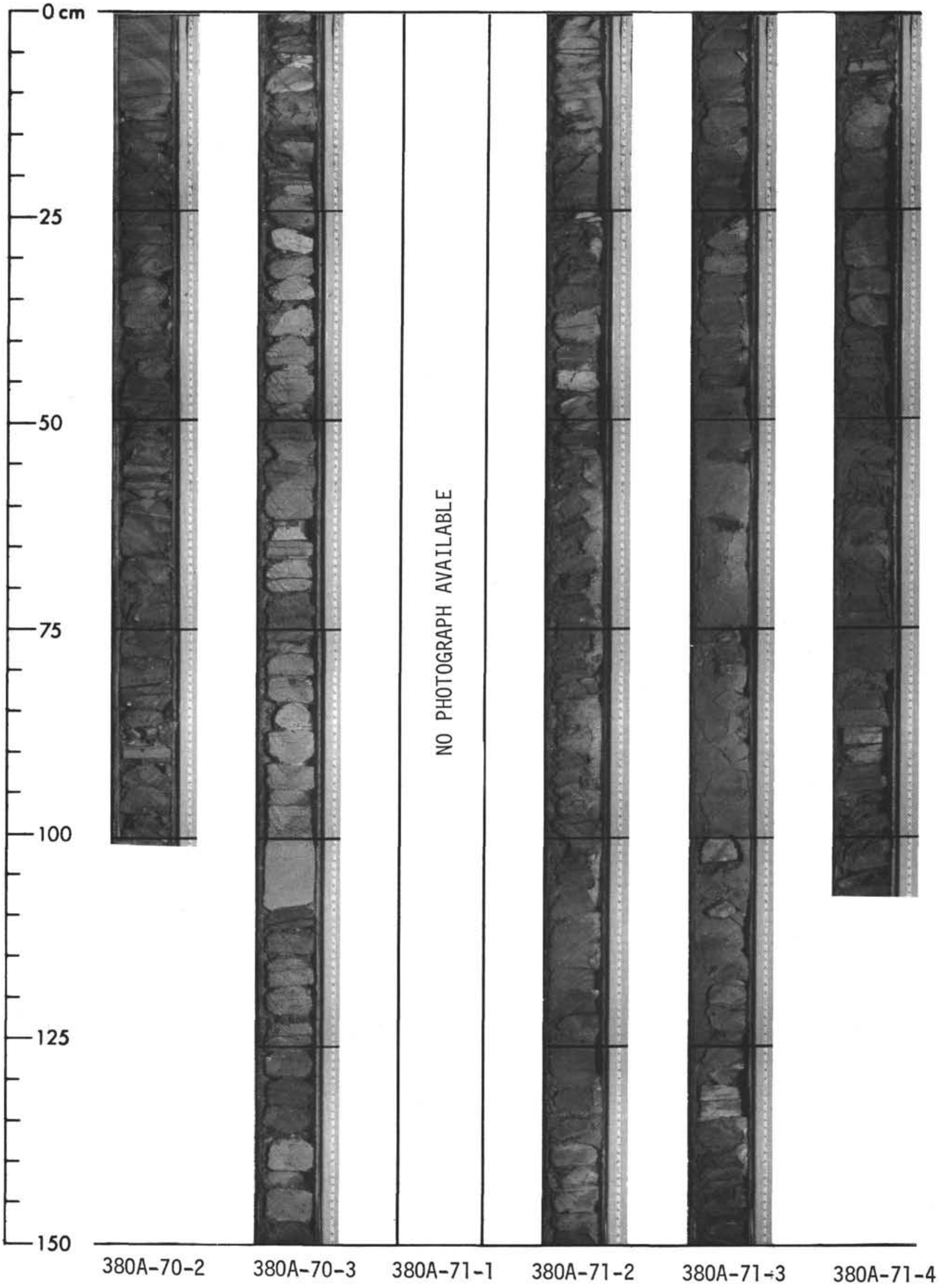
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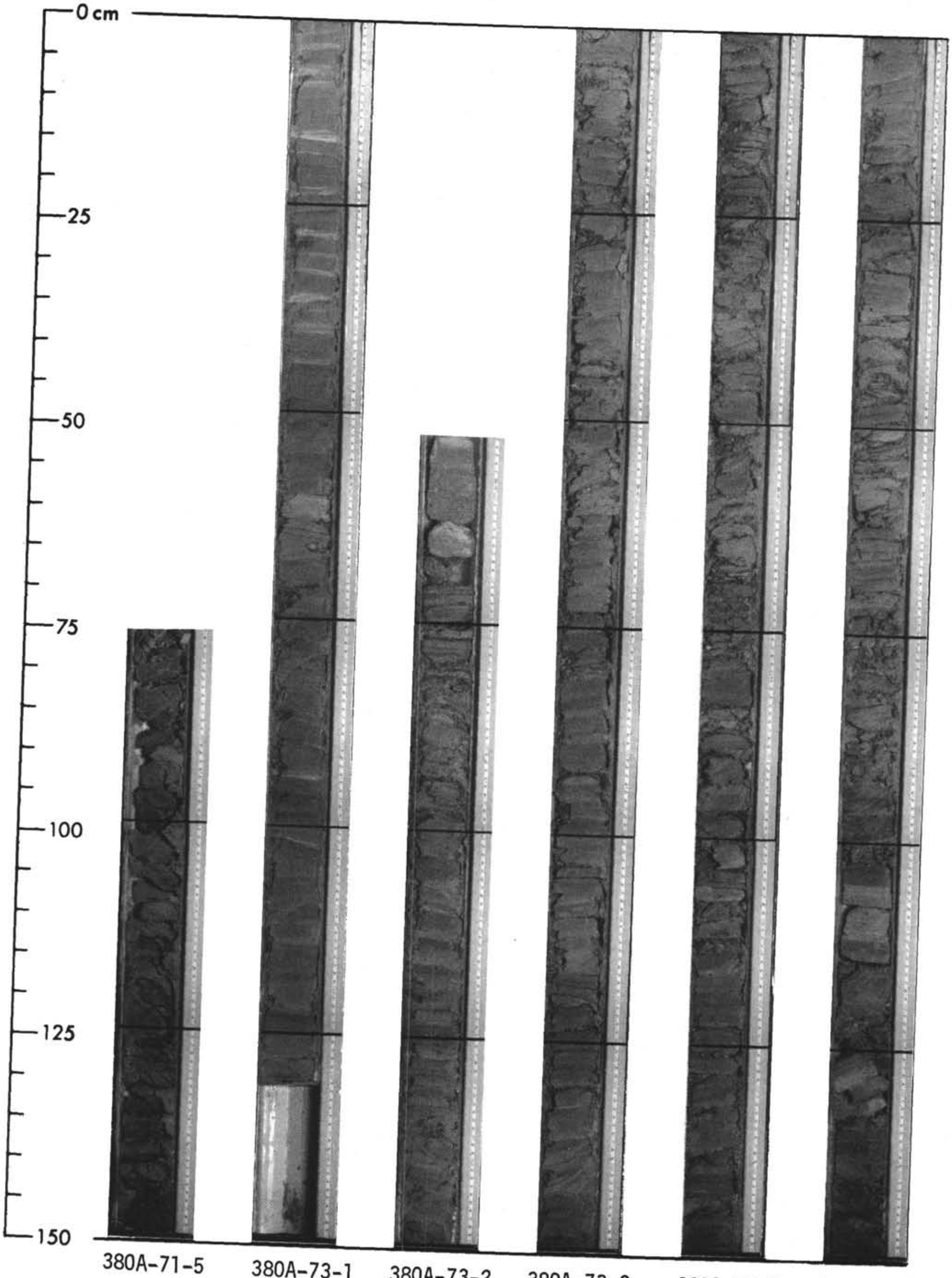
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380A-74-2
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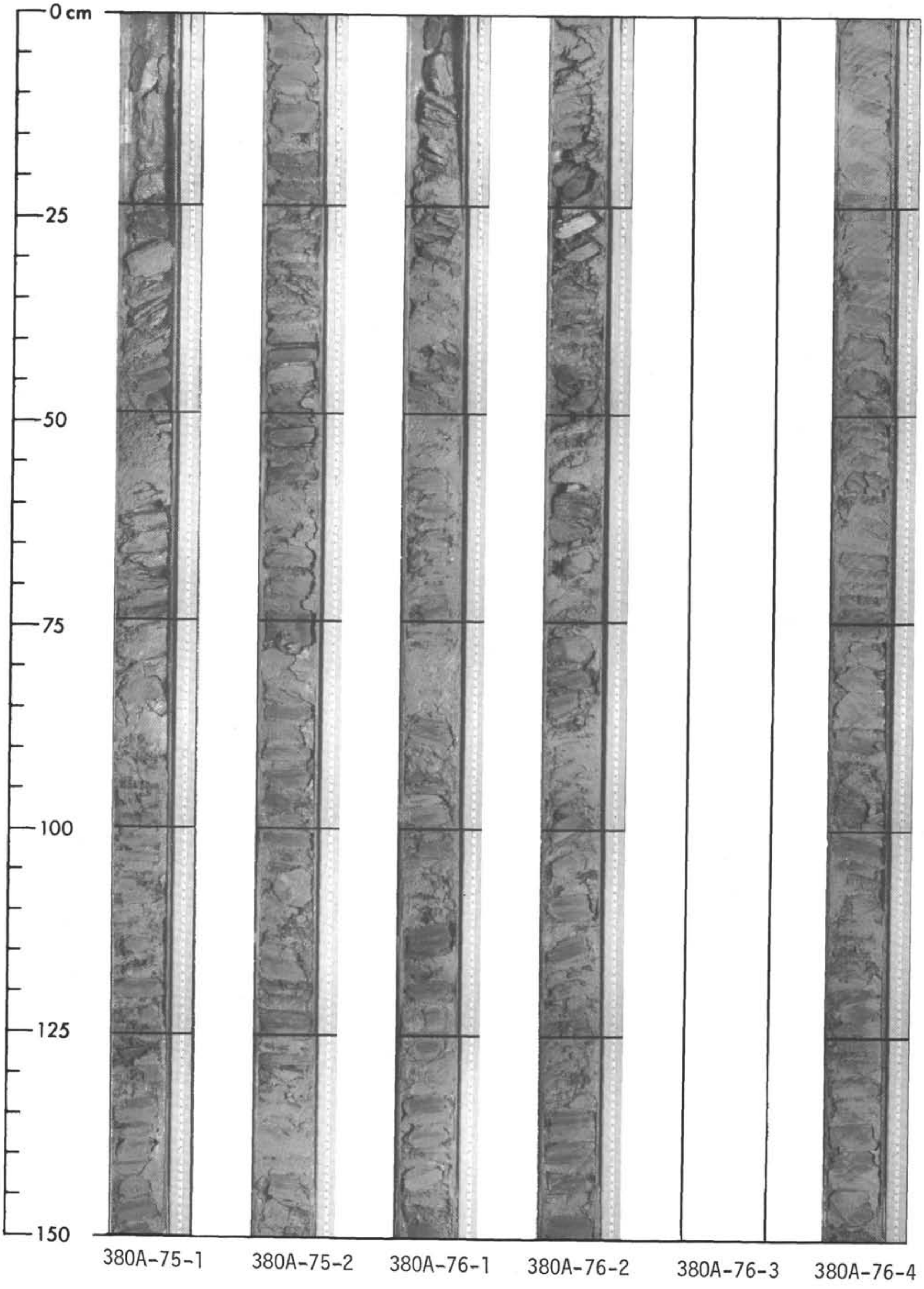
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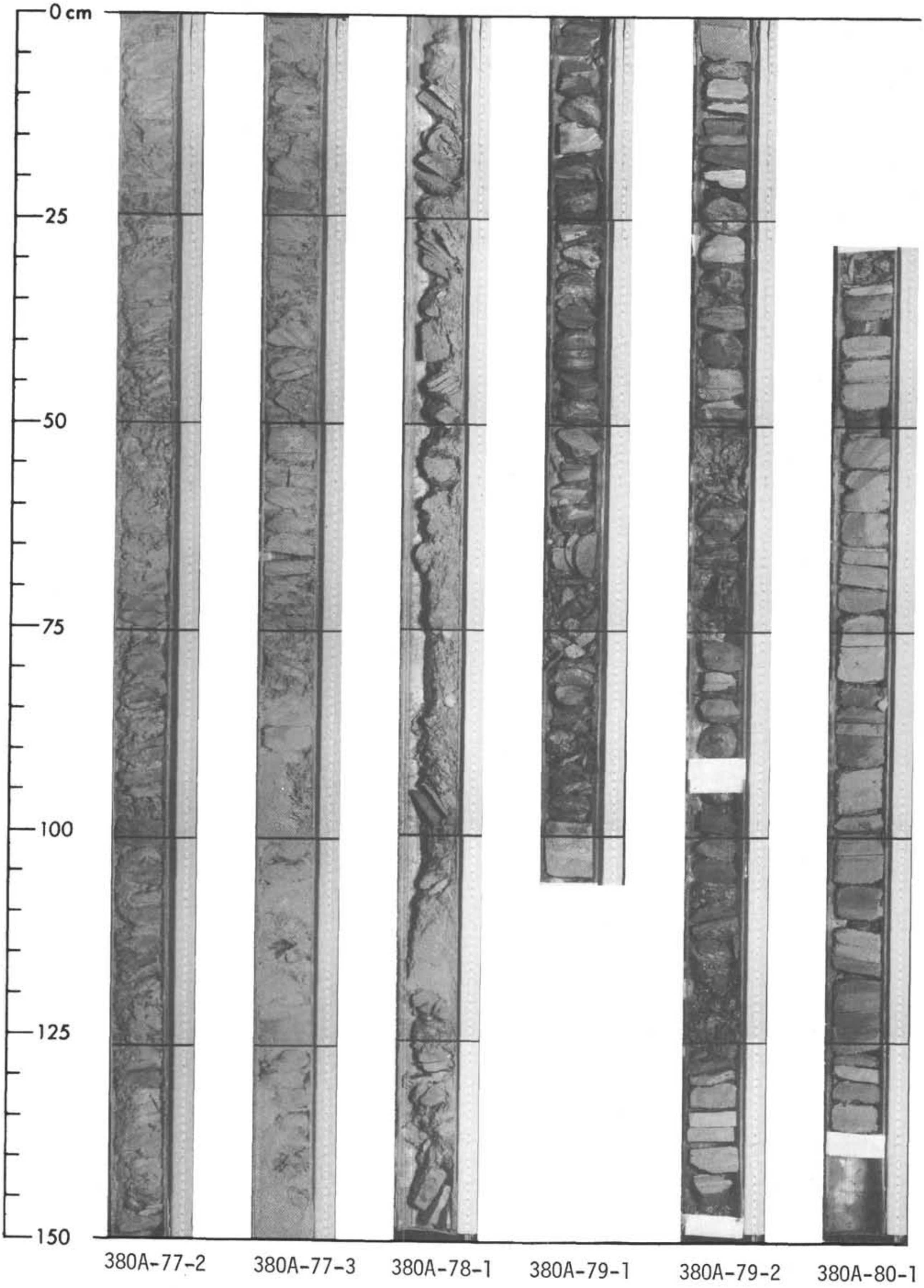
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380A-80-1